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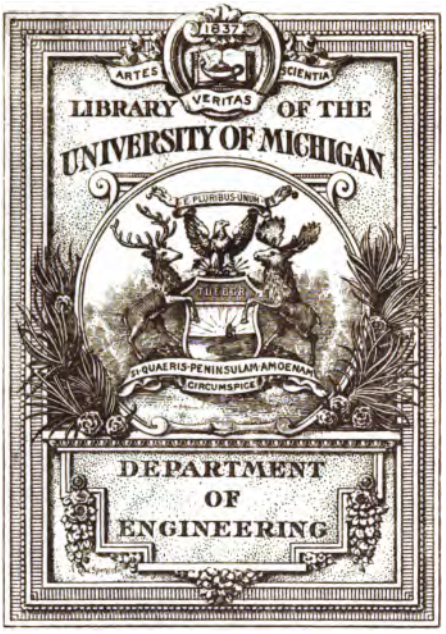

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REPORT ON

CONDITIONS OF EMPLOYMENT IN THE IRON AND STEEL INDUSTRY

IN THE

UNITED STATES

IN 4 VOLUMES

VOLUME IV: ACCIDENTS AND ACCIDENT PREVENTION

Prepared under the direction of
CHAS. P. NEILL
Commissioner of Labor

WASHINGTON
GOVERNMENT PRINTING OFFICE
1913

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IN THE SENATE OF THE UNITED STATES,

August 21, 1911.

Resolved, That the report of the Secretary of Commerce and Labor concerning the conditions of employment prevailing in the iron and steel industry of the United States, submitted in compliance with Senate resolution numbered Two hundred and thirty-seven, Sixty-first Congress, second session, be printed, with accompanying illustrations, as a public document.

Attest:

CHARLES G. BENNETT,
Secretary.

By HENRY H. GILFRY,
Chief Clerk.

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LETTERS OF TRANSMITTAL.

DEPARTMENT OF COMMERCE AND LABOR,
OFFICE OF THE SECRETARY,
Washington, August 9, 1912.

SIR: In compliance with Senate resolution No. 237 of June 23, 1910, I have the honor to transmit herewith a report dealing with accidents and accident prevention in the iron and steel industry in the United States, being Volume IV, the last volume, of the Report on Conditions of Employment in the Iron and Steel Industry in the United States.

The resolution in response to which these data are transmitted reads as follows: "*Resolved*, That the Department of Commerce and Labor, through the Bureau of Labor, be, and is hereby, directed to investigate and report to the Senate as early as possible as to the conditions of employment prevailing in the iron and steel industry of the United States, with the details concerning the wages paid, the hours of labor per day and the number of days' labor per week, and the number employed."

Respectfully,

CHARLES NAGEL,
Secretary.

Hon. JAMES S. SHERMAN,
President of the Senate, Washington, D. C.

DEPARTMENT OF COMMERCE AND LABOR,
BUREAU OF LABOR,
Washington, August 9, 1912.

SIR: I beg to transmit herewith the fourth volume of the report embodying the results of the investigation into the conditions of employment prevailing in the iron and steel industry in the United States, which was undertaken in compliance with Senate resolution 237 of June 23, 1910.

This section of the report deals with the subject of accidents in this industry, together with the recent movement inaugurated for the prevention of accidents and with the systems recently established for the payment of compensation in cases of injury by accident. The field work in connection with this study has been done by Lucian W.

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Chaney, special agent of the Bureau of Labor. Mr. Chaney has devoted two years to the collection of data in the field, during which time he has made a careful study of the processes in the steel plants and of the hazard involved in the various occupations in the production of iron and steel. He has also assembled the material and prepared the report. In this work he has received valuable assistance from Herman L. Amiss, of the editorial division of the Bureau. The preparation of the report has been under the general direction of Chas. H. Verrill.

I am, very respectfully,

CHAS. P. NEILL,
Commissioner.

The SECRETARY OF COMMERCE AND LABOR,
Washington, D. C.

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INTRODUCTION AND SUMMARY.

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INTRODUCTION AND SUMMARY.

While heretofore data have not been available from which accident rates could be computed to measure accurately the dangers of employment in any manufacturing industry in the United States, the iron and steel industry has been generally regarded as one of the most hazardous of our manufacturing industries. Naturally, then, a report on the conditions of employment in the industry called for a compilation of accident records, a careful study of conditions under which accidents occur, and the fullest consideration of possible measures of accident prevention.

In this investigation complete information as to accidents during the year ending June 30, 1910, for 155 plants, representing a working force of 158,604 employees, equivalent to 146,979 300-day workers, showed an accident rate for accidents of all kinds of 245.2 per 1,000 300-day workers, or 1.86 for fatal accidents, 2.72 for accidents resulting in permanent injury, and 240.6 for accidents resulting in temporary disability of one day and over. The accidents resulting in temporary disability comprised the great portion of all accidents (98.1 per cent), those resulting fatally and in permanent injury together constituting only 1.9 per cent.

Not all the departments of the iron and steel industry involve equal hazards to the employees, rates in 1910 ranging from 423.1 per 1,000 in the Bessemer department down to 50 per 1,000 in puddling. Next to the Bessemer department hand rolling mills show the highest rate, 366.4 per 1,000, while open-hearth steel works have a rate of 340.1 per 1,000, mechanical rolling mills 309.5 per 1,000, and blast furnaces 257.4 per 1,000. In mechanical departments the rate was 238.0 per 1,000, in yards 151.0 per 1,000, and in steel foundries 133.4.

The above rates, representing accident conditions in the industry as a whole in 1910, cover a wide range of conditions in the various plants. On the one hand, for a large group of plants in which the work of organized accident prevention is well developed the rate falls as low as 167.1 per 1,000 300-day workers, while at the other extreme, for a group of plants in which organized safety work has not yet been developed the rate rises to 507.9 per 1,000, and in the case of individual plants in the group considerably higher.

As already noted, 98.1 per cent of all accidents in 1910 were those resulting in a temporary disability of one day and over, the fatal and permanently disabling accidents together making up only 1.9 per cent of all. Based on the records of the two years ending June 30,

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1910, complete figures as to duration of disability were secured for 19,458 nonfatal accidents in establishments with 65,147 300-day workers. Of these injuries the per cent terminating in the first week was 52.1 for blast furnaces, 48.1 for steel works, 49.6 for rolling mills, 55.0 for mechanical occupations, and 51.0 for yards, the average for the five departments being 50.8 per cent. For the departments combined 22.8 per cent of the nonfatal injuries terminated in the second week, 9.8 per cent in the third, 5.2 per cent in the fourth, 4.1 per cent in the fifth, and 6.4 per cent in the sixth and later. It will be seen that for the first week no department varies widely from the average; a similar relative condition was found for the second, third, and later weeks.

The economic loss to the individual workman who is injured is indicated by the amount of time lost due to disablement. From the records of the same two years ending June 30, 1910, the average time lost yearly per injury (taking no account of fatal accidents and of permanent impairment of earning power) in the departments of 130 plants was found to be: In steel works 14.2 days, in yards 14.1 days, in blast furnaces 13.3 days, in mechanical departments 13 days, in rolling mills 12.2 days, and in foundries 10 days.

But while the average economic loss per accident is accurately represented in the foregoing figures (with the exceptions noted), they do not properly show the loss when spread over the whole industry and applied to each workman. A fairer showing for comparative purposes of the yearly economic loss to employees resulting from accidents is on the basis of the loss per 300-day worker. When so computed the average time lost yearly for each 300-day worker is found to be highest in steel works (6.20 days), followed in order by rolling mills (4.42 days), blast furnaces (4.30 days), mechanical occupations (3.14 days), yards (2.44 days), and foundries (1.75 days). These figures, it will be noted, show the same ranking of departments as to hazard as is indicated by the number of accidents per 1,000 300-day workers. No account is here taken, however, of fatal accidents.

Injuries to the hands and feet and general bruises and lacerations of other parts of the body form the larger part of all injuries in the industry. A combination of the available data showing proportion of injuries of each kind, together with average days lost per injury, indicated that injuries to the hand, constituting 25.9 per cent of all injuries, involved an average loss per injury of 13 days, while those to the feet, constituting 17.4 per cent of all injuries, involved an average loss of 16 days. Burns, with 15 per cent of the cases, averaged a loss of 19 days. Fractures showed the highest average loss per injury, 29 days, but represented only 2.6 per cent of the total number of injuries.

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Owing to continuous operation during the day and night, the iron and steel industry has a more uniform working force throughout the 24 hours than almost any other industry and presents favorable opportunity for determining the distribution of accidents according to hour of occurrence. Information covering 26,839 accidents shows that the largest percentage of accidents in the first half of the day turn occurred from 9 to 10 a. m. and in the second half from 2 to 3 p. m.; in the night turn the largest percentages were from 7 to 8 p. m. and from 2 to 3 a. m. The distribution during the morning and afternoon shown for this industry corresponds closely with that indicated by data of nearly equal volume in various manufacturing industries presented in a preceding investigation.[1]

It is not possible to correlate directly in the same plant the hour of accident and the hour-to-hour speed of production, but in one Bessemer plant, where production records for the Bessemer converters are available for an eight-months' period, it was found that the hour of maximum production in morning, afternoon, and first half of night was later and in second half of night earlier than the hour of greatest accident occurrence in the Bessemer departments of another large plant during a period of years.[2]

The figures which have already been given not only show the relation of the accident rate for the industry as a whole compared with plants having high and low standards, but they serve to show also the possibilities of improvement by organized safety work. Thus a comparison of the accident records of a group of plants in which safety work has been fully developed with a group in which such work has not been done shows a rate of 167.1 per 1,000 300-day workers for the former group and 507.9 for the latter group, a reduction of 67.1 per cent, or of 2 accidents out of every 3. The greatest part of this accident reduction appears in the accidents resulting in temporary disabilities, but a reduction of 21.5 per cent in the permanent-disability rate and of 30.2 per cent in the fatal-accident rate will indicate that the saving extends to accidents of practically every class.

For a satisfactory understanding of accident conditions in an industry an intensive study is necessary of the records for a period of years. A large steel plant was found which had records extending over a series of years; its accident-prevention and safety-organization work extended throughout the period, and it combined a greater variety of occupations than are usually found in one plant. This plant normally employed about 8,000 men, of whom only about 23 per cent were Americans. During the period 1905 to 1910 the

[1] Report on Condition of Woman and Child Wage-Earners in the United States, Vol. XI: Employment of Women in the Metal Trades, p. 96.

[2] See p. 84.

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percentage of employees in productive occupations, based on maximum figures for each year, increased from 49 per cent to 69 per cent, with a corresponding decrease of those in nonproductive occupations. As the productive occupations are on the whole more dangerous than the nonproductive, this fact is significant.

Individual accident records were available for 7,750 cases of disabling injury during the six-year period mentioned. These records afford interesting information regarding accident occurrence during a period of activity in safety effort in a single plant, and illustrate in a striking way the possibilities of a reduction of accidents by organized safety work. In this period the rate for disabling accidents (including both fatal and nonfatal) was reduced from 427 per 1,000 300-day workers in 1905 to 179 per 1,000 in 1910 in blast furnaces, from 429 to 212 in the Bessemer department, from 304 to 185 in the open-hearth department, and from 248 to 185 in yards. Other departments showed similar reductions. In steel works (Bessemer and open-hearth) the rates were high at the outset, and even with the reduction occurring during the period remained higher in the final year than those in the other departments, indicating the serious problem presented in these departments. The rate for all departments decreased from 300 to 133.5 during the period, or 55.5 per cent. While the greatest part of this reduction was in temporary disabilities, marked improvement is shown in both fatality and permanent-disability rates.

Investigation of the duration of disability showed for the whole plant a marked decrease in the proportion of accidents terminating in the first week. These constituted 52 per cent of all cases in 1905, but only 38 per cent in 1910. When the disabilities terminating in specified weeks are presented in the form of rates per 1,000 300-day workers, a decrease in 1910 as compared with 1905 is found for nearly every one of the weeks, showing that although the most marked decrease was in disabilities terminating in the first week, all classes of injury, from the minor to the severe, were diminished by the safety movement.

In time lost by the workers on account of accidents the mechanical department showed the greatest improvement, the average days lost per 300-day worker decreasing from 4.75 in 1905 to 1.82 in 1910, or 62 per cent. This was followed by blast furnaces, with a reduction from 5.62 to 3.35, or 40 per cent; foundries, 5.13 to 3.51, or 32 per cent; Bessemer steel works 6.12 to 4.35, or 30 per cent; rolling mills, 3.11 to 2.32, or 25 per cent; open-hearth steel works, 5.24 to 4.86, or 7 per cent; and yards, 3.26 to 3.23, or only 1 per cent. While the accident rate in yards declined from 248 to 185 per 1,000 300-day workers during the six-year period under discussion, showing considerable progress, the small reduction in days lost per 300-day

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worker indicates that safeguarding methods in yards have not kept pace with those in other departments.

More than half of the accidents during the six-year period in the plant investigated were due to four causes, viz, flying and falling objects, 25.2 per cent; falls of the worker, 10.5 per cent; hot-metal explosions and spills, 8.9 per cent; and the operation of cranes, 8 per cent, these causes maintaining from year to year a substantially unchanged relation to each other. The accident rates per 1,000 300-day workers due to each cause showed in almost every case a large decrease in 1910 as compared with 1905, and in accidents peculiar to blast furnaces and rolling mills remarkable decreases were produced by the application of safety devices.

As in the case of injuries from specified causes those of each specified nature maintained a fairly constant relation to each other during the six years. The rates for permanent injuries were reduced from 2.2 per 1,000 300-day workers in 1905 to 0.5 per 1,000 in 1910, injuries to the eyes declined in rates from 19.7 to 4.1, bruising injuries to the hands from 58.7 to 27.2, bruises to the feet from 46.4 to 22.8, and bruises to other parts of the body from 72.6 to 26.6. Burns by hot metal were reduced from 16.5 to 6.8 per 1,000 300-day workers, and this reduction is important as showing the improvement in conditions in the highly dangerous blast furnaces and steel works.

Study was made of the relation to accidents of the long turn in continuous occupations, such as those connected with blast furnaces. In the blast furnaces of the plant under discussion it was found that for the whole period there was a slightly higher accident rate on Sunday than on other days of the week. Figures were available for three other blast furnaces covering a period of two years, showing that the rate for Sunday considerably exceeds that of any other day. The data do not cover a sufficient number of cases to justify positive conclusions, but appear to indicate a tendency to greater frequency of accidents during the long turns.

Regarding accidents in day and night work, it was found that there was a distinct excess of the night over the day rates. For the whole six-year period in the large plant investigated this amounted to 11.6 per cent. For the departments the percentage of excess of night over day rates was 2.1 per cent in blast furnaces, 27.3 per cent in Bessemer steel works, 31.1 per cent in open-hearth steel works, 39.2 per cent in rolling mills, 118.3 per cent in mechanical occupations, and 127.6 per cent in yards. The causes of the extremely high rates for the night force in mechanical operations and in yards are discussed in full on page 154.

In connection with efforts for the prevention of accidents, some notably successful examples of safety departments are found in some of the larger plants in the iron and steel industry. These usually

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consist of systems of inspection, educational work, and direct safety appliances. The safety committee, as a method of securing cooperation in safety efforts, is very widely employed. Charts showing the results of safety effort from month to month, the setting of standards to which efforts are made to reduce the accident rates, and comparison of safety results with those of similar establishments are all means used for securing greater safety in the industry. One result of the efforts of safety committees has been to secure in behalf of such work the experience and executive ability of those who have developed the industry. These committees also engage in the work of spreading information regarding the prevention of accidents not only to superintendents and foremen but also to the workmen.

Direct safeguarding methods constitute a most important feature of the safety movement and are considered in detail in Chapter IV of this report. The conditions in each department are given, together with a description of special safety devices. The discussion affords a comprehensive view of the active efforts for the prevention of accidents in the iron and steel industry.

In the appendixes are presented in detail the data upon which the statistical portion of the report is based, together with a tabulation showing the extent of hospital treatment in 530 plants and a sample constitution of a benefit association.

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CHAPTER I.

ACCIDENTS IN THE IRON AND STEEL INDUSTRY IN 1910.

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CHAPTER I.

ACCIDENTS IN THE IRON AND STEEL INDUSTRY IN 1910.

INTRODUCTION.

To discuss adequately and fully the accident problem in any industry, it is necessary to possess exact information covering a series of years. No American industry has records affording such a body of information.

In the iron and steel industry individual companies have kept fairly complete records, but frequently these have not been retained after their probable value in the adjustment of claims ceased. In those States where the industry is most largely developed, the bureaus of labor have not been engaged long in the accumulation of records, and they have been unable to treat the records which they have accumulated in such a way as to afford satisfactory information. The following discussion is therefore largely a pioneer effort, subject to all the difficulties which always surround such attempts. The body of facts presented will, it is hoped, both shed some light upon the existing situation and serve as a substantial basis for the continuous inquiries which must be maintained for a number of years if a thorough understanding of conditions is to be obtained.

An industry so vast, with hazards so great and multiform, presents a difficult problem. In order to present accurate results the accident cases must be, to a considerable extent, collected and studied individually. The tabulations presented in this report will give some idea of the labor involved in such a consideration.

As a basis for the development of this report an effort was made to secure complete data for a period of two years ending June 30, 1910. The industrial conditions of these two years were very unlike and it was impossible to secure accurate information regarding the number employed during the first of the two years. For these reasons comparisons (except of a very general character) between the years are not possible. As a supplement to this body of data representing the industry as a whole a special study of one large individual plant was made where complete records were available for a period of years.

The materials assembled as above indicated fall into three groups:

(1) Detailed information regarding individual accidents from 274 plants. The cases recorded numbered 7,774 for 1909 and 12,788 for 1910.

(2) A tabulation of nonfatal accidents for each of the two years from 60 plants, but not giving details for each accident. This tabu-

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lation covers 15,621 accidents in 1909 and 25,598 in 1910. For these 60 plants details were secured in cases of fatal injury. This group and the preceding group, covering for 1910, 210,614 employees, furnish the major portion of the material used in Chapter I.

(3) Details regarding 7,750 accidents occurring in one large plant during a period of six years. These data were secured by agents of the Bureau directly from the original records. This group is treated in Chapter II.

Much confusion has resulted in the discussion of accidents in America from the fact that we have no standard classification. The insurance companies demand a report for "every case of bodily injury however trivial." Some of the State bureaus have followed the same rule. Others place various limitations upon the accidents to be reported. New York, for example, prior to October 1, 1910, excluded all which did not involve at least five hours of detention from work. In other States the excluded cases are those causing disability of under one, two, or three weeks. Frequently in the discussions of material presented these limitations have not been clearly indicated. The result is that it is impossible to determine whether the accidents discussed by one bureau are of the same character as those which are under discussion by another. For example, comparisons have been made between conditions in this country and in Germany, which have ignored entirely the fact that the German accident figures include no temporary disabilities of 13 weeks and under.

DISABLING ACCIDENTS.

It will be necessary to lay repeated emphasis upon the definition of disabling accidents. As already pointed out, the uncertainties of classification among those who have discussed American accidents are so great that even by the closest study it is difficult to ascertain whether their results are comparable. This report deals mainly with disabling accidents, namely, those causing a disability of one day or more. The much larger number of cases in which the worker is either not at all disabled or in which the disability is less than one day are classed as nondisabling accidents. Of the bodily injuries recorded by insurance companies, at least 60 per cent are in this class of nondisabling accidents. These require prompt and skillful attention in order that they may not develop into something serious; but since they take the worker for a relatively short period from his work and do not greatly interfere with the prosecution of the work, they are not of very great economic significance. At a later point there will be developed the imperative reasons for bestowing careful medical and surgical attention upon these minor injuries.

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DETERMINATION OF ACCIDENT RATES.

Prior to the discussion of tables of disabling accidents an explanation of the methods employed in determining some of their elements is necessary. To a computation of accident rates three factors are essential: First, the number of accidents; second, the number of workers employed; and third, the length of time of their employment. To make comparisons from establishment to establishment and department to department these factors must be used in such a way as to reduce to a common denominator the things to be compared. Two establishments may each require 500 workers for their full operation. If one operates throughout the entire year while the other is in operation but eight months, it is evident that a simple comparison of the number of employees in each with the number of accidents occurring in that year can not give comparable rates. The method pursued by the German Imperial Insurance Office for securing a basis for comparison is as follows: The different establishments are required to report each year the number of "man days" for their establishment. A "man day" is one man working for one day. If an establishment with 100 men works 250 days out of a year it will have a total of 25,000 "man days." If different departments of the establishment work a different number of days the number of "man days" in each department must be determined, and the total of these will be the number of days for the plant. Having determined in terms of working days the amount of human labor in the industrial plants of the Empire, it is necessary to reduce these to some common basis. This is done by assuming a working year of 300 days. The number of "man days" reported by each establishment is divided by 300, the quotient being what the Germans call "full-time workers" (*Vollarbeiter*). For example, in the establishment mentioned above with 25,000 "man days," division by 300 gives 83 "full-time workers" as equivalent to the 100 workers actually employed to operate the plant. Since as a rule plants operate somewhat less than the full 300 days, the number of these "full-time workers" is usually less than the actual operating force. In the somewhat rare cases in which a plant or department operates in excess of 300 days the number of "full-time workers" would be greater than the operating force in proportion to the excess of operating time above 300 days.

In order to secure in the present report a basis similar to that used by the German Imperial Insurance Office, it was necessary to secure a statement of the operating force and the number of days in operation for each department. It was possible to do this for 75 per cent of the workers considered in the report.[1] Multiplying the number of

[1] The total number of positions shown is 210,614. For 158,604 of these it was possible to determine the equivalent number of 300-day workers.

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workers by the actual number of days during which they were at work and dividing this product by 300, we arrive at figures similar to those used in Germany. Since such a figure has not been often used in the discussion of American data, it is thought better to use the somewhat more explicit designation "300-day workers" than to transfer the German term. Accordingly this designation is used throughout the report.

The operative force for the year 1910 was determined by taking the number of positions shown by the plant pay rolls for a period of two weeks in May, 1910. It should be understood that this does not mean the number of names on the pay roll. If, as might easily happen, several different men occupied a given position during this pay-roll period, they are not reported as individuals, but the position is reported.

The admission of this pay roll as exactly representing the operating force is not strictly accurate. The operating force fluctuates to a greater or less degree with the activity of the mill. Output and employment are closely related. The variation in employment for different periods may be determined approximately by comparing the outputs. The table presented below shows the average daily output of blast furnaces for 1910, month by month, and the portion of pig iron produced which is used in steel works. This furnishes a reliable index of the employment of the specified periods in blast furnaces and steel works and also indicates something regarding activity in rolling mills, since the ingot production of the steel works is nearly all rolled immediately.

AVERAGE DAILY OUTPUT OF BLAST FURNACES IN 1910, BY MONTHS.

[From Iron Age, January 5, 1911, page 6.]

Months.	Pig iron production.	Pig iron used in steel works.
	Gross tons.	*Gross tons.*
January	84,148	57,200
February	85,616	57,876
March	84,459	56,113
April	82,792	55,663
May	77,102	52,235
June	75,516	51,637
July	69,305	47,183
August	67,963	46,534
September	68,542	47,007
October	67,520	45,794
November	63,659	41,427
December	57,252	35,909
Average for year	73,656	49,548
Average per year below May (per cent)	4.5	5.3

It appears from the table that the average daily production, and consequently average employment, during the entire year was below that of May by 4.5 per cent in blast furnaces and 5.3 per cent in steel works. A study of the exact employment figures of six very large

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composite plants from month to month shows their number of employees in May to have been 34,535. The average for the year was 33,124, or 4 per cent below that for May.

Considering the situation in the light of these facts, it is evident that the number employed in May was above the average for the entire year. The calculated number of 300-day workers is accordingly slightly greater than the true number, and the rates are correspondingly depressed.

It did not seem desirable, however, to attempt the application of any correction to the figures for two reasons: (1) The resulting changes would not be of sufficient amount to be of real significance, and no essential relations would be modified by using a correction; (2) since all plants are not alike in their condition, a uniform correction was likely to introduce as many errors as it would correct.

The number of 300-day workers was accordingly calculated on the basis of the positions shown by the reported pay roll in the manner indicated above. It was found that the number of 300-day workers thus derived was 92.7 per cent of the working force.

DISABLING ACCIDENTS, BY PLANTS.

In the following table are shown statistics for disabling accidents occurring in 155 plants for which the necessary information for the calculation of rates was obtainable. The number of fatal accidents included in this table is less than that shown in the general fatality table, page 87. This is due to the fact that the information with regard to certain plants was imperfect. For example, a number of plants were not in operation during the month for which the pay roll was requested, and the number of employees was not ascertained. Some of these plants, however, made returns for accidents for the two years. This makes it possible to include them in some tables, but necessarily excludes them from those showing rates.

ACCIDENTS IN ALL PLANTS REPORTING SUFFICIENT DATA FOR THE DETERMINATION OF 300-DAY WORKERS, YEAR ENDING JUNE 30, 1910.

Plant number.[1]	Positions shown on pay roll.	300-day workers.	Number of accidents.			
			Fatal.	Permanent injury.	Temporary disability, 1 day and over.	Total.
1	207	158	.....	1	14	15
2	189	142	.....	.....	10	10
3	2,447	2,348	.....	1	46	47
4	360	438	.....	.....	27	27
5	636	481	4	4	31	39
6	116	141	.....	.....	17	17
7	207	198	.....	.....	57	57
8	100	90	.....	.....	9	9
9	1,103	1,135	1	9	120	130
10	455	358	.....	1	24	25

[1] For data as to departments of plants see Appendix A.

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ACCIDENTS IN ALL PLANTS REPORTING SUFFICIENT DATA FOR THE DETERMINATION OF 300-DAY WORKERS, YEAR ENDING JUNE 30, 1910—Continued.

Plant number.	Positions shown on pay roll.	300-day workers.	Number of accidents.			
			Fatal.	Permanent injury.	Temporary disability, 1 day and over.	Total.
11	187	123	.....	.....	14	14
12	495	401	1	9	207	217
13	269	245	.....	.....	31	31
14	739	725	.....	2	17	19
15	52	29	.....	.....	3	3
16	1,051	858	4	3	139	146
17	792	596	1	4	104	109
18	679	665	1	3	84	88
19	438	405	.....	1	19	20
20	1,637	1,238	1	.....	76	77
21	257	192	.....	.....	58	58
22	551	540	.....	1	28	29
23	307	377	2	.....	30	32
24	580	401	.....	1	91	92
25	240	266	.....	.....	35	35
26	614	551	.....	3	76	79
27	613	593	.....	1	76	77
28	241	235	.....	.....	22	22
29	257	251	1	2	41	44
30	362	246	.....	2	307	309
31	766	592	.....	1	55	56
32	154	110	2	.....	120	122
33	356	369	1	3	29	33
34	142	172	1	1	19	21
35	132	62	.....	1	38	39
36	173	158	.....	.....	13	13
37	495	578	1	.....	42	43
38	322	392	4	.....	16	20
39	347	327	1	3	64	68
40	347	302	.....	1	47	48
41	333	222	.....	4	51	55
42	457	556	1	.....	95	96
43	456	452	1	2	131	134
44	342	236	.....	.....	18	18
45	507	500	.....	1	19	20
46	92	84	.....	.....	8	8
47	231	172	1	.....	24	25
48	1,244	1,200	1	3	111	115
49	133	130	.....	.....	45	45
50	163	127	1	.....	9	10
51	176	130	.....	2	10	12
52	169	135	.....	2	53	55
53	887	790	.....	2	91	93
54	339	300	1	1	24	26
55	262	85	.....	.....	14	14
56	815	325	.....	4	66	70
57	5,342	5,461	4	14	1,713	1,731
58	827	421	.....	2	116	118
59	6,105	6,137	4	15	862	881
60	2,000	1,048	.....	2	240	242
61	3,768	3,503	10	1	624	635
62	378	318	1	.....	88	89
63	288	248	1	.....	92	93
64	1,827	1,669	2	.....	605	607
65	761	487	2	.....	213	215
66	4,112	4,185	11	5	1,157	1,173
67	969	885	3	1	276	280
68	8,017	8,109	19	7	2,089	2,115
69	626	543	.....	.....	79	79
70	1,141	851	3	1	315	319
71	632	469	1	.....	197	198
72	1,287	1,098	.....	.....	430	430
73	893	806	.....	.....	313	313
74	376	288	.....	.....	143	143
75	716	525	.....	.....	186	186
76	736	471	1	.....	203	204
77	211	197	.....	.....	39	39
78	567	517	1	.....	154	155
79	2,953	2,907	11	3	856	870
80	1,394	1,272	2	1	549	552
81	1,376	1,296	3	1	794	798
82	1,707	1,659	3	2	456	461
83	370	290	1	1	110	112
84	105	90	.....	.....	19	19
85	134	128	.....	.....	29	29
86	116	100	.....	1	27	28

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ACCIDENTS IN ALL PLANTS REPORTING SUFFICIENT DATA FOR THE DETERMINATION OF 300-DAY WORKERS, YEAR ENDING JUNE 30, 1910—Concluded.

Plant number.	Positions shown on pay-roll.	300-day workers.	Number of accidents.			
			Fatal.	Permanent injury.	Temporary disability, 1 day and over.	Total.
87	52	28	.....	.....	18	18
88	1,319	1,364	4	8	156	168
89	866	910	1	1	175	177
90	422	502	.....	1	122	123
91	1,054	905	2	3	248	253
92	125	106	1	1	48	50
93	102	98	.....	2	24	26
94	116	102	.....	.....	40	40
95	201	139	1	1	84	86
96	118	69	.....	.....	51	51
97	42	24	.....	.....	15	15
98	602	319	.....	2	151	153
99	4,061	4,131	7	10	1,232	1,249
100	160	173	.....	.....	29	29
101	2,637	2,348	5	4	548	557
102	1,181	1,084	1	2	238	241
103	7,542	7,642	12	5	1,270	1,287
104	6,560	6,225	20	11	969	1,000
105	956	690	1	4	172	177
106	1,136	1,106	5	5	226	236
107	108	131	1	.....	35	36
108	663	710	.....	2	70	72
109	1,112	806	1	3	95	99
110	133	133	1	.....	22	23
111	94	96	.....	.....	7	7
112	583	409	1	3	211	215
113	376	289	.....	1	57	58
114	638	439	.....	6	138	144
115	720	876	.....	3	259	262
116	5,382	5,572	22	58	1,255	1,335
117	357	297	.....	.....	19	19
118	227	186	2	.....	23	25
119	844	647	2	4	32	38
120	1,215	975	.....	7	106	113
121	721	695	1	2	132	135
122	2,407	2,596	2	8	417	427
123	229	168	.....	2	47	49
124	617	540	.....	.....	11	11
125	650	689	.....	4	56	60
126	240	202	.....	1	37	38
127	1,130	1,131	1	2	478	481
128	1,066	903	.....	4	218	222
129	288	252	2	1	61	64
130	172	209	1	.....	27	28
131	1,272	1,170	.....	3	374	377
132	10,163	9,726	24	25	5,095	5,144
133	6,701	6,833	14	25	1,941	1,980
134	2,425	1,827	4	7	156	167
135	424	311	.....	.....	58	58
136	214	220	.....	1	49	50
137	102	121	.....	.....	14	14
138	4,208	3,369	11	14	654	679
139	347	340	.....	3	92	95
140	510	532	.....	.....	76	76
141	62	48	.....	.....	2	2
142	331	273	.....	2	21	23
143	219	185	.....	1	72	73
144	954	782	.....	4	46	50
145	1,396	1,491	7	5	589	601
146	174	180	1	.....	83	84
147	623	620	.....	.....	100	100
148	530	583	.....	.....	43	43
149	124	114	.....	.....	16	16
150	1,021	825	.....	1	90	91
151	236	218	1	.....	31	32
152	1,093	936	.....	1	58	59
153	293	292	.....	1	71	72
154	106	69	.....	.....	1	1
155	97	92	.....	.....	4	4
Total	[1]158,604	146,979	274	400	35,364	36,038
Rate per 1,000 300-day workers	.....	.....	1.86	2.72	240.6	245.2

[1] The total plants covered by the investigation showed for 1910 210,614 positions on their payrolls. Of these positions 75 per cent were in the 155 plants here reported.

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The operating force shown in this table is 158,604, and the number of 300-day workers is 146,979. The table includes as follows: (1) All plants of the United States Steel Corporation coming within the scope of the investigation which were in operation in May, 1910; (2) all the large independent companies with the exception of three; and (3) smaller companies to the number of 93. The necessity for the exclusion of some of the companies requires brief explanation. Of the three large independent companies omitted, the Bethlehem Steel Company[1] had been the subject of a report by the Bureau of Labor prior to the beginning of the present investigation. It was not, therefore, included in this study, except its provisions for the safeguarding of its workmen and care of the injured. One company did not submit any data. The data from the third were imperfect in a way which made them of no use for the purposes of this table.

The smaller plants not here included numbered 175. The reports from these companies were incomplete at some point and while satisfactory for some purposes could not be used in a general table requiring information complete at all points.

If any plant showed a percentage of cases terminating in the first week markedly under 40 per cent, it was not included. The reason for adopting this rule should be stated in detail. For plants having 65,147[2] 300-day workers the number of disabilities terminating in successive weeks was accurately known. Approximately 51 per cent terminated in the first week, 23 per cent in the second, 10 per cent in the third, 5 per cent in the fourth, 4 per cent in the fifth, and 6 per cent extended over 5 weeks. In no case did the percentage terminating in the first week fall below 45 per cent. It appeared clear from this that with complete reporting the number terminating in the first week would constitute from 40 to 50 per cent in this industry. Any marked decline of the disabilities terminating in the first week below the lower limit would suggest that some of the shorter disabilities were not reported.

In the case of the large company excluded as being imperfect in its records, the disabilities terminating in the first week as reported were but 20 per cent of all reported. An examination of the methods of recording confirmed the conclusion suggested by the percentages. In the plant in question three independent records are kept: Hospital record, a claims department record, and an emergency-room record. Many of the short-period disabilities are recorded only in the emergency room. Not being considered sufficiently serious to require hospital attention or to be of interest in the claims department, they are not recorded by either of these. The record submitted to the bureau was that of the claims department and did not contain the shorter disa-

[1] Report on Strike at Bethlehem Steel Works, South Bethlehem, Pa., 1910, Senate Document No. 521, 61st Congress, 2d session.

[2] See p. 50.

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bilities whose record was to be found only in the emergency room. In some plants pursuing a similar method emergency treatments are not recorded.

The facts disclosed in this examination appear to warrant the conclusion that under normal conditions in this industry 40 to 50 per cent of all temporary disabilities terminate in the first week. If the percentage is below this the record should be regarded as imperfect, in the absence of definite evidence from other sources of its completeness.

The accident rates per 1,000 300-day workers shown by this table are as follows: Fatal, 1.86; permanent injury, 2.72; temporary disability, one day or over, 240.6; total, 245.2. This table may be accepted as showing approximately the conditions in 1910 in the entire group of plants under consideration. It covers blast furnaces, steel works, rolling mills, and steel foundries. Each plant included in the table has at least one of the departments, while a considerable number of the plants have all the departments.

In volumes I and II of this report, dealing with hours and wages, the plants of the country are arranged in certain geographical districts. These districts are as follows: The "New England" district, including the New England States and the eastern and central part of the State of New York; the "Eastern" district, including New Jersey, eastern and central Pennsylvania, Delaware, and Maryland; the "Pittsburgh" district, including western Pennsylvania, northern West Virginia, and eastern Ohio; the "Great Lakes and Middle West" district, including the plants about Buffalo, those adjacent to the Great Lakes—Cleveland, Toledo, Chicago, etc.—with a few scattered plants lying westward as far as Colorado; the "Southern" district, including southern Ohio and all southern States except Maryland; the "Pacific coast" district, including a few plants in Washington, Oregon, and California.

The table under consideration represents each of these districts in about the same proportion as the tables of the report on hours and wages, the Eastern and Southern districts being somewhat deficient. In the Southern district there are a very considerable number of small isolated blast furnaces. These without exception keep very imperfect records of their accidents and so were unable to respond satisfactorily to the request for data.

It should be noted in passing that in the preceding table the number of positions on the pay roll is shown for each plant. It was not thought necessary to include this item in all the tables presented. It seemed desirable to include it in this general table in order to illustrate the relation already explained as existing between the positions shown by the pay roll and the number of 300-day workers. All rates are calculated on the basis of 300-day workers.

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DISABLING ACCIDENTS, BY DEPARTMENTS OF PLANTS.

The following tables present the reported facts with regard to the accidents in the individual departments. They include in each department all for which it was possible to determine the number of 300-day workers. For purposes of comparison the number of positions shown on the pay roll is included in these tables. As already explained, the number of 300-day workers is usually somewhat less than the number of operating positions. Wherever the number is greater it indicates that the plant was in operation in excess of 300 days. This condition naturally occurs more frequently in blast furnaces than in the other departments, the average time in operation for all blast furnaces reported in this investigation being 308 days for the year 1910. If it is desired for any purpose to determine the number of days in operation for an individual plant or for the aggregate of the plants, it may be done by multiplying the number of 300-day workers shown by 300 and dividing the result by the number of positions shown on the pay roll.

BLAST FURNACES.

The following table shows for blast furnaces the number of 300-day workers, together with the number of accidents which occurred during the year, classified according to whether they were fatal or caused permanent injury or temporary disability:

ACCIDENTS IN BLAST FURNACES REPORTING SUFFICIENT DATA FOR DETERMINATION OF 300-DAY WORKERS, YEAR ENDING JUNE 30, 1910.

Plant number.	Positions shown on pay roll.	300-day workers.	Number of accidents.			
			Fatal.	Permanent injury.	Temporary disability, 1 day and over.	Total.
4	360	438	.....	.....	27	27
5	64	61	.....	3	.....	3
6	116	141	.....	.....	17	17
23	307	373	2	.....	30	32
25	240	266	.....	.....	35	35
32	154	110	2	.....	120	122
33	356	369	1	3	29	33
34	142	172	1	1	19	21
35	132	62	.....	1	38	39
36	173	158	.....	.....	13	13
37	495	578	1	.....	42	43
38	322	392	4	.....	16	20
42	457	556	1	.....	95	96
43	456	452	1	2	131	134
47	231	172	1	.....	24	25
50	163	127	1	.....	9	10
57	350	272	1	2	162	165
59	400	354	.....	2	165	167
60	121	49	.....	1	44	45
61	754	817	4	.....	192	196
62	378	318	1	.....	88	89
63	288	248	1	.....	92	93
64	161	146	1	.....	161	162
65	175	117	1	.....	56	57
66	392	365	1	.....	198	199
67	308	341	.....	1	89	90
68	1,005	1,213	2	2	207	211
76	286	200	.....	.....	51	51
79	417	448	1	1	150	152
80	329	273	2	1	284	287

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ACCIDENTS IN BLAST FURNACES REPORTING SUFFICIENT DATA FOR DETERMINATION OF 300-DAY WORKERS, YEAR ENDING JUNE 30, 1910—Concluded.

Plant number.	Positions shown on pay roll.	300-day workers.	Number of accidents.			
			Fatal.	Permanent injury.	Temporary disability, 1 day and over.	Total.
81	375	346	1	1	252	254
82	166	157	.....	.....	69	69
98	227	269	.....	2	41	43
89	164	196	.....	.....	47	47
90	422	502	.....	1	122	123
91	100	40	2	.....	18	20
99	516	511	2	2	122	126
100	160	173	.....	.....	29	29
101	308	307	1	.....	49	50
102	106	86	1	.....	31	32
103	1,188	1,298	3	1	196	200
104	478	416	3	.....	115	118
107	108	131	1	.....	35	36
108	663	710	.....	2	70	72
110	133	133	1	.....	22	23
111	94	96	.....	.....	7	7
115	720	876	.....	3	259	262
116	523	549	5	1	125	131
118	227	186	2	.....	23	25
129	288	252	2	1	61	64
130	172	209	1	.....	27	28
132	771	783	2	5	385	392
133	899	1,013	3	8	107	118
136	214	220	.....	1	49	50
137	102	121	.....	.....	14	14
138	193	148	.....	.....	42	42
145	248	288	.....	2	86	88
Total	19,097	19,604	60	50	4,937	5,047
Rate per 1,000 300-day workers	.....	.....	3.06	2.55	251.8	257.4

In Volume I of this report, relating to wages and hours of labor, the fact that blast furnaces must operate continuously has been discussed. As above stated the blast furnaces presented in this report operated on the average 308 days for the year under consideration. In only one other department, open-hearth steel works, is the average operating period in excess of 300 days, and there only slightly. This relation is worth calling attention to because from the fact of continuous operation a slightly exaggerated idea of the working year of blast furnace employees might easily be obtained. Aside from the facts conveyed by the detailed presentation of the table, it is desirable to note that if the plants be divided into two groups on the basis of size, those having 500 employees or less in one group and those having over 500 in the other, the general rate for the group of smaller plants is definitely higher than that for the larger plants. The plants with 500 300-day workers or less have a total of 10,198 such workers and 3,077 accidents, making the accident rate 301.7 per 1,000. The plants having over 500 300-day workers aggregate 9,406 such workers, the accidents number 1,970, and the rate is 209.4.

This is true in spite of the fact that some of the larger plants have very unsatisfactory conditions. The explanation of this higher rate in the smaller plants falls under two heads: First, in these smaller plants the older methods of operation, involving the carrying of the

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ore and other raw materials from the stock piles to the furnace in barrows and their handling at the top of the furnace by "top fillers," are still in use. These methods are likely to cause an increased number of accidents in two ways: (1) The number of men necessary to carry on the operations is much greater, and (2) the exposure of the individual man to falling objects, asphyxiating gas, and unexpected explosions is also greater. Second, the smaller plants have not yet been reached and influenced in the same degree as have the larger ones by the safety movement. Their small size and the consequent small number of accidents have tended to obscure the fact that their rate is very high. It has already been pointed out that a judgment founded upon the accident rate for a single year is open to serious question, but the showing of the smaller plants of a tendency toward higher rates from plant to plant indicates the need of more effective safety measures in such plants.

BESSEMER STEEL WORKS.

In the following table are presented the data for disabling accidents occurring in Bessemer steel works:

ACCIDENTS IN BESSEMER STEEL WORKS REPORTING SUFFICIENT DATA FOR DETERMINATION OF 300-DAY WORKERS, YEAR ENDING JUNE 30, 1910.

Plant number.	Positions shown on pay roll.	300-day workers.	Number of accidents.			
			Fatal.	Permanent injury.	Temporary disability, 1 day and over.	Total.
61	357	273	1	.....	61	62
67	195	165	1	.....	53	54
68	178	114	1	.....	61	62
76	204	112	1	.....	91	92
79	275	238	2	1	117	120
80	201	182	.....	.....	90	90
81	282	268	1	.....	106	107
89	199	193	.....	1	74	75
91	216	207	.....	2	51	53
101	269	270	1	.....	86	87
103	351	338	1	1	89	91
116	363	432	3	3	104	110
132	418	346	1	2	384	387
138	395	393	1	1	65	67
145	133	137	2	.....	93	95
Total	4,036	3,668	16	11	1,525	1,552
Rate per 1,000	.....	.....	4.36	3.00	415.8	423.1

In the discussion of fatal accidents the two principal forms of steel making—the Bessemer process and the open-hearth process—are not separated. The number of Bessemer plants and the number employed therein are in each case very much smaller than the numbers for the open hearth plants. While for general purposes it has been desirable to combine these plants under the heading "steel works," the hazards are sufficiently different to warrant the presentation of individual tables. The rates in Bessemer steel works are the

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highest found anywhere in the industry, except that the switchmen in the yard department have a higher fatality rate than any single occupation in Bessemer steel making. The conditions productive of excessive hazard in these works are presented at greater length elsewhere,[1] but it is proper to summarize them here. First, the throwing of large masses of scrap into the converter causes risk, in the absence of special safeguards, that these masses will fall to the floor below and inflict serious injury. Second, the shower of sparks constantly issuing from the converter during a "blow" frequently causes minor burns and occasionally more severe burns. Third, in the operation of the hot metal ladles the occurrence of a "spill" has been more or less frequent, endangering those who work upon the floor of the converter. Fourth, the explosions due to the presence of small quantities of moisture have been frequent and in a good many cases disastrous.

OPEN-HEARTH STEEL WORKS.

The next table relates to disabling accidents occurring in open-hearth steel works:

ACCIDENTS IN OPEN-HEARTH STEEL WORKS REPORTING SUFFICIENT DATA FOR DETERMINATION OF 300-DAY WORKERS, YEAR ENDING JUNE 30, 1910.

Plant number.	Positions shown on pay roll.	300-day workers.	Number of accidents.			
			Fatal.	Permanent injury.	Temporary disability, 1 day and over.	Total.
5	82	59	1	1	7	9
9	59	61	.....	.....	5	5
12	116	120	.....	3	32	35
16	159	118	2	2	18	22
17	280	290	1	.....	37	38
24	47	39	.....	.....	8	8
26	59	70	.....	2	2	4
27	87	103	.....	.....	13	13
29	119	122	.....	.....	11	11
31	40	36	.....	.....	6	6
39	134	145	.....	1	21	22
49	16	13	.....	.....	5	5
53	63	35	.....	.....	1	1
64	347	344	1	.....	136	137
65	121	79	.....	.....	57	57
66	875	887	3	2	285	290
68	1,514	1,509	3	2	507	512
79	326	324	2	1	158	161
82	281	300	1	.....	71	72
83	100	69	1	1	39	41
88	271	276	2	3	49	54
89	59	60	.....	.....	15	15
91	92	92	.....	1	61	62
99	332	343	.....	2	107	109
103	804	828	1	.....	191	192
104	733	613	7	3	311	321
116	452	545	1	6	135	142
120	166	157	.....	.....	9	9
131	405	408	.....	3	161	164
132	487	593	2	3	480	485
134	157	157	2	2	49	53
140	200	222	.....	.....	12	12
Total	8,983	9,017	30	38	2,999	3,067
Rate per 1,000 300-day workers	.....	.....	3.33	4.21	332.6	340.1

[1] See pp. 226 to 229.

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The combined rate for open hearth and Bessemer is the highest found in the industry. When presented separately each is higher than the other departments; the Bessemer much higher, the open hearth by a decided margin. This high proportion in these particularly characteristic departments of the industry is evidence that steel mills have problems peculiarly their own. In a table on page 146 it appears that in such works 68 per cent of the injuries are related to the special processes.

A careful study [1] of fatal accidents in the iron and steel industry in Allegheny County, Pa., shows that for that group of accidents only 19 per cent were due to characteristic operations. This has sometimes been regarded as showing that steel-mill dangers are much like those of other industries. This conclusion must be much modified when the whole problem is taken into consideration. Not less than 42 per cent of all disabling accidents in the iron and steel industry are in connection with the special dangers.[2] When loss of time is considered the characteristic operations become still more important.[3]

The conclusion drawn from these conditions in open hearth and Bessemer steel works by many steel men, namely, that their industry was so different from others that effective effort in the reduction of accidents was impossible, is shown to be untenable.[4]

A comparison between large and small plants in steel making in the above tables will not show the same degree of contrast that is shown in the blast furnaces. There is, however, sufficient indication of a higher rate in the smaller plants to suggest that the adoption of mechanical methods as seen in the larger establishments has had the same influence here as in the blast furnaces.

PUDDLING.

The next table shows the number of disabling accidents of each class occurring in the puddling departments:

ACCIDENTS IN PUDDLING FOR PLANTS REPORTING SUFFICIENT DATA FOR DETERMINATION OF 300-DAY WORKERS, YEAR ENDING JUNE 30, 1910.

Plant number.	Positions shown on pay roll.	300-day workers.	Number of accidents.			
			Fatal.	Permanent injury.	Temporary disability, 1 day and over.	Total.
1	42	35	.....	.....	.....	.....
15	52	29	.....	.....	3	3
21	84	56	.....	.....	6	6
52	9	8	.....	.....	4	4
105	187	151	.....	.....	15	15
112	121	100	.....	.....	2	2
114	130	115	.....	.....	9	9
138	275	193	.....	.....	10	10
141	42	33	.....	.....	2	2
147	152	173	.....	.....	3	3
148	170	199	.....	.....	2	2
150	123	147	.....	.....	6	6
Total	1,387	1,239	.....	.....	62	62
Rate per 1,000 300-day workers	.....	.....	.....	.....	50.0	50.0

[1] Eastman, Work Accidents and the Law, p. 72. [2] See p. 146. [3] See pp. 58 and 59. [4] See p. 57.

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This process is the oldest of the purification methods by which iron is produced. While the occupation is an exceedingly laborious one, its hazards are not very great. Much difficulty was experienced in treating the puddling department in view of the fact that the payments of workers are so largely on a contract basis. The employer makes a contract with a chief puddler to produce iron at a certain rate per ton. The contracting puddler then hires his own assistants and the amount paid to them is often unknown to the employer. This method of procedure rendered the determination of the operating positions difficult and uncertain. The plants included in the table were all for which a determination was possible. The table does not, therefore, represent at all completely the industry of producing puddled iron. In the detailed table of fatalities by occupation two puddlers appear as having lost their lives in the course of the year. It is accordingly appropriate to explain that they are not included in this table, because the plant in which the accident occurred did not furnish complete data and because the records disclosed that the death of the puddlers was due to the explosion of an adjacent boiler and not to an incident of their proper occupation.

ROLLING MILLS.

The table which follows relates to accidents in mechanically operated and in hand-operated rolling mills:

ACCIDENTS IN ROLLING MILLS REPORTING SUFFICIENT DATA FOR DETERMINATION OF 300-DAY WORKERS, YEAR ENDING JUNE 30, 1910.

MECHANICAL OPERATION.

Plant number.	Positions shown on pay roll.	300-day workers.	Number of accidents.			
			Fatal.	Permanent injury.	Temporary disability, 1 day and over.	Total.
5	62	38			1	1
12	160	113		1	26	27
17	188	60			32	32
24	22	7			2	2
27	22	20			5	5
28	37	32			2	2
29	44	39		1		1
30	124	98	1		19	20
61	625	500	1		121	122
64	281	205			107	107
65	59	35	1		18	19
66	388	389	1	1	136	138
67	130	109	2		57	59
68	2,014	1,964	1	3	705	709
70	377	274	1	1	76	78
71	122	78			50	50
76	93	50			31	31
79	377	364	2		118	120
80	166	134			58	58
81	195	187			116	116
82	345	297		1	140	141
88	124	119			15	15
89	79	77			12	12
91	183	181			55	55
99	576	592	1	2	329	332
101	261	262	1	1	98	100
102	564	529		1	123	124
103	2,054	1,961	3	2	373	378
104	1,089	1,004	3	3	223	229
106	208	198			23	23
116	1,579	1,583	4	21	368	393
120	81	63			2	2

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ACCIDENTS IN ROLLING MILLS REPORTING SUFFICIENT DATA FOR DETERMINATION OF 300-DAY WORKERS, YEAR ENDING JUNE 30, 1910—Concluded.

MECHANICAL OPERATION—Concluded.

Plant number.	Positions shown on pay roll.	300-day workers.	Number of accidents.			
			Fatal.	Permanent injury.	Temporary disability, 1 day and over.	Total.
131	523	445	.....	.....	126	126
132	1,597	1,371	3	2	539	544
134	89	85	.....	.....	4	4
145	100	103	3	.....	21	24
Total	14,938	13,566	28	40	4,131	4,199
Rate per 1,000 300-day workers	.....	.....	2.06	2.95	304.5	309.5

HAND OPERATION.

1	143	108	.....	1	13	14
2	117	88	.....	.....	7	7
7	114	98	.....	.....	27	27
8	100	90	.....	.....	9	9
10	116	93	.....	.....	2	2
12	40	29	.....	.....	21	21
21	103	81	.....	.....	38	38
24	108	79	.....	1	22	23
26	79	55	.....	.....	3	3
27	229	211	.....	.....	26	26
40	153	138	.....	1	7	8
41	137	74	.....	.....	3	3
44	261	180	.....	.....	10	10
46	92	84	.....	.....	8	8
51	143	110	.....	.....	1	1
52	78	51	.....	.....	7	7
54	80	65	.....	1	4	5
65	71	42	.....	.....	15	15
66	432	420	.....	1	165	166
68	65	63	.....	.....	24	24
69	409	336	.....	.....	57	57
70	384	356	1	.....	114	115
71	308	241	.....	.....	87	87
72	636	543	.....	.....	328	328
73	436	393	.....	.....	189	189
74	264	202	.....	.....	117	117
75	435	308	.....	.....	123	123
77	159	145	.....	.....	21	21
78	351	307	.....	.....	117	117
80	82	65	.....	.....	30	30
82	83	80	.....	.....	32	32
83	147	115	.....	.....	46	46
84	105	90	.....	.....	19	19
85	134	128	.....	.....	29	29
86	116	100	.....	1	27	28
87	52	28	.....	.....	18	18
88	194	162	.....	1	29	30
91	118	101	.....	.....	63	63
92	125	106	1	1	48	50
93	102	98	.....	2	24	26
94	116	102	.....	.....	40	40
95	201	139	1	1	84	86
96	118	69	.....	.....	51	51
97	42	24	.....	.....	15	15
98	154	120	.....	2	43	45
101	533	384	1	.....	53	54
105	236	154	.....	.....	100	100
109	672	487	1	1	59	61
112	235	149	.....	2	66	68
113	98	75	.....	.....	27	27
115	186	119	.....	3	64	67
116	197	191	.....	3	56	59
117	164	166	.....	.....	11	11
119	99	76	.....	.....	2	2
120	115	70	.....	1	18	19
132	1,332	1,317	2	4	908	914
135	111	81	.....	.....	12	12
138	103	102	3	.....	16	19
140	66	64	.....	.....	5	5
145	351	363	.....	1	164	165
146	174	180	1	.....	83	84
147	219	180	.....	.....	65	65
Total	12,823	10,675	11	28	3,872	3,911
Rate per 1,000 300-day workers	.....	.....	1.03	2.62	362.7	366.4

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The separation of the rolling mills into two groups, mechanically operated and hand operated, was made because of the belief that the hazards in the two cases were quite distinctly different and should, if possible, be made evident. For purposes of comparison, the rates in the two tables are here brought together. They are: Mechanically operated—fatal accidents, 2.06 per 1,000 300-day workers; permanent injury, 2.95; temporary disability, 1 day or over, 304.5; total, 309.5. Hand operated—fatal accidents, 1.03 per 1,000 300-day workers; permanent injury, 2.62; temporary disability, 362.7; total, 366.4. Simple inspection of these rates indicates the nature of the difference known to exist in these two classes of mills. For fatality and permanent injury the mechanical mills show the higher rate—in fatalities very pronouncedly higher. In the temporary disabilities the hand-operated mills show a considerably higher rate. The explanation of this difference is in the nature of the apparatus and the character of the material handled. If a man is caught in one of the moving parts of the mechanically operated mill, severe or fatal injury is more likely to be the result than in the hand operated mill. On the other hand, where the men themselves handle the heated billets and manage with tongs and hooks the material as it is rolled, their risk of temporary disablement by burns and similar injury is decidedly greater. It may be noted further that reduction of accidents is more prompt in the mechanical mills. The dangers of unprotected gears, of absence of means for crossing the roll tables, and of unprotected spindles are easily provided against. On the other hand, the danger of a man who actually handles the metal at the rolls has perhaps increased rather than diminished in recent years. The speed of the rolls is greater, and he must be both quicker and more accurate than the man occupying the same position in former times. The only remedies apparent for this higher hazard are the more careful selection of men and the more liberal use of "spell hands." This statement applies, of course, to the mills where direct handling of the metal by the roll hands is now and probably for a long time will continue to be necessary. Constantly with the development of the industry mills are being transferred to the mechanically operated division and in this way the general hazard of the production of rolled material is being constantly lessened.

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MECHANICAL DEPARTMENTS.

The number of disabling accidents of each class occurring in mechanical departments are shown in the table which follows:

ACCIDENTS IN MECHANICAL DEPARTMENTS FOR PLANTS REPORTING SUFFICIENT DATA FOR DETERMINATION OF 300-DAY WORKERS, YEAR ENDING JUNE 30, 1910.

Plant number.	Positions shown on pay roll.	300-day workers.	Number of accidents.			
			Fatal.	Permanent injury.	Temporary disability, 1 day and over.	Total.
1	22	15			1	1
5	111	84	1		5	6
9	83	85			7	7
10	57	45			1	1
16	82	67			9	9
17	31	26			7	7
20	600	454			5	5
21	9	7			1	1
24	88	59			9	9
26	78	70		1	21	22
27	75	72		1	7	8
29	9	7			1	1
31	79	61			12	12
39	48	45		1	13	14
44	22	15				
61	1,014	943	1	1	83	85
64	400	352			82	82
65	132	84			20	20
66	1,104	1,089	2		196	198
67	158	127			30	30
68	934	934	2		229	231
69	40	33			2	2
70	124	90	1		33	34
71	60	45			15	15
72	117	100			15	15
73	92	83			19	19
74	52	40			22	22
76	64	40			10	10
78	38	32			4	4
79	772	780	1		152	153
80	245	206			41	41
81	254	240	1		136	137
82	380	370	1		67	68
89	259	272	1		27	28
99	1,275	1,296	1	4	377	382
101	574	504	1	1	93	95
102	245	225		1	33	34
103	1,255	1,259	1		107	108
104	1,945	1,888		2	152	154
105	105	76	1	1	16	18
109	85	61			15	15
112	74	52	1	1	93	95
113	29	22			7	7
114	39	29			12	12
116	927	924	2	9	103	114
120	133	107			9	9
121	105	110			9	9
127	138	147			46	46
128	66	56			11	11
131	131	121			37	37
132	2,827	2,704	3	7	1,397	1,407
138	711	597	2		191	193
145	254	271		1	103	104
Total	18,551	17,421	23	31	4,093	4,147
Rate per 1,000 300-day workers			1.32	1.78	234.9	238.0

The conditions disclosed by this table are of such a varied nature that the general rates are probably less significant than in any of the other departments. The mechanics in a steel plant have such a wide

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range of occupation and carry on their work under such different conditions that to group them together may not seem strictly appropriate. It has not been possible in any considerable number of cases to isolate individual occupations and determine the question of their hazard. Those mechanics engaged in making repairs are subjected to the greater risk. A very considerable number of these accidents are not simply those of the occupation, but are such as arise from the unexpected starting of machinery, or from the work of others in the vicinity, or from such accidents as the leakage of gas into the space where the work is being done. The rates, therefore, shown for these mechanical occupations are undoubtedly higher than would be shown by the same occupations in other industries. The mechanic in the steel works must many times encounter not only the natural hazard of his occupation but a special hazard incident to the place where he does his work. To what extent these special hazards affect the situation it is not possible from the material at hand exactly to determine.

YARDS.

The following table presents the information regarding accidents in yards:

ACCIDENTS IN YARDS REPORTING SUFFICIENT DATA FOR DETERMINATION OF 300-DAY WORKERS, YEAR ENDING JUNE 30, 1910.

Plant number.	Positions shown on pay rolls.	300-day workers.	Number of accidents.			
			Fatal.	Permanent injury.	Temporary disability, 1 day and over.	Total.
2	25	19			3	3
5	294	222	2		16	18
9	42	43	1		8	9
10	109	86			4	4
16	39	32			17	17
17	164	137		1	23	24
20	200	151			2	2
21	52	41			8	8
24	54	37			32	32
26	99	89			13	13
27	119	117			6	6
31	372	289			10	10
39	16	15		1	11	12
44	45	31			5	5
61	475	442			22	22
64	412	363			17	17
65	100	64			2	2
66	533	526	4	1	20	25
67	96	77			1	1
68	1,361	1,360	7		89	96
69	102	84			12	12
70	157	115			58	58
71	108	80	1		7	8
72	351	300			21	21
73	288	260			25	25
74	60	46			4	4
76	18	11			3	3
78	151	129	1		4	5
79	553	539	2		12	14
80	263	221			6	6
81	125	118			73	73

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ACCIDENTS IN YARDS REPORTING SUFFICIENT DATA FOR DETERMINATION OF 300-DAY WORKERS, YEAR ENDING JUNE 30, 1910—Concluded.

Plant number.	Positions shown on pay rolls.	300-day workers.	Number of accidents.			
			Fatal.	Permanent injury.	Temporary disability, 1 day and over.	Total.
82	364	354	1	1	15	17
99	1,169	1,188	3	.....	249	252
101	456	409	.....	1	80	81
102	125	115	.....	.....	51	51
103	957	884	3	1	129	133
104	998	915	5	1	80	86
105	381	275	.....	.....	30	30
109	316	229	.....	.....	8	8
112	88	62	.....	.....	9	9
113	201	155	.....	.....	8	8
114	265	163	.....	.....	45	45
116	867	866	5	11	229	245
120	238	191	.....	.....	42	42
121	149	156	.....	.....	12	12
127	110	117	.....	.....	25	25
128	209	177	.....	.....	8	8
131	209	192	.....	.....	50	50
132	2,024	1,936	5	1	482	488
133	1,212	1,239	1	4	94	99
138	675	563	4	.....	118	122
145	179	191	2	.....	115	117
Total	17,975	16,441	47	23	2,413	2,483
Rate per 1,000 300-day workers	.....	.....	2.86	1.40	146.8	151.0

It appears in this table that the fatalities in yard operations numbered 47 and represented a rate of 2.86 per 1,000 300-day workers. These figures are not much lower than those of blast furnaces, which had 60 fatal accidents and a rate of 3.06 per 1,000, and for Bessemer and open-hearth steel works, which together had 46 fatal accidents and a combined rate of 3.63 per 1,000. The table includes a number of employees, such as common laborers, engaged in laying tracks, cleaning up the yards, and other general work, who, while they must be classed as yard employees, are not engaged in distinctively yard operations. The hazards of these employees are low. While this fact may have modified the rate to some extent, the high fatality rate in yards is chiefly due to the extremely high rate for switchmen. Of the 47 fatal accidents, 27 were accidents to switchmen, who numbered 990 300-day workers, making the fatal-accident rate for this occupation 27.3 per 1,000. The 20 remaining fatalities in yards were distributed among a total of 15,451 300-day workers, making the low rate of 1.3 per 1,000 for employees other than switchmen. The rate of 151.0 per 1,000 for accidents of all kinds indicates that yard occupations as a whole are less hazardous than many others.

Plants employing more than 500 had 10,036 300-day yard laborers who experienced 1,560 accidents, or at the rate of 155.5 per 1,000. Plants with 500 or less employed 6,405 300-day workers; the acci-

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dents numbered 923, and the rate was 144.2. The rate for the larger plants is not markedly higher, but is nevertheless of considerable significance in view of the fact that among blast furnaces the larger plants have the lower rate.[1] These rates are brought out because of the fact that yard operation is not as well organized for safety as that of other departments in the steel mills. On pages 99 to 101 this has been discussed as affecting the yard fatalities, and the particulars in which yard operation seems to be still deficient have been in some measure indicated. The large plants have uniformly adopted mechanical methods of production and of handling material within the mills to a much greater extent than the small plants. The congestion due to their growth, and possibly the fact that much of the railroad operation within the plants is controlled by independent corporations, has helped to bring about this condition of higher accident rates for the large plants. Upon the point regarding outside control of transportation some further explanation is desirable. In the shipping yards of the large plants the railway companies interested in the product of the mills very frequently have their own tracks. When this is the case there is a degree of divided responsibility, the railway controlling in some particulars and the operating company in others. In addition to this, a considerable number of companies having large transportation problems in connection with the operation of their mills have organized what are frequently called "connecting railways." These are broad-gauge roads, and being as a rule operated independently of the control of the Interstate Commerce Commission, have not adopted all the devices required of interstate carriers. Even where the safety movement has taken root in the operation of the mills it has not always extended to the operation of the associated railway companies. This situation is probably not a little responsible for an apparently backward condition in safeguarding yard operations.

[1] See p. 29.

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STEEL FOUNDRIES.

The following table presents information as to accidents to employees engaged in steel foundries:

ACCIDENTS IN STEEL FOUNDRIES REPORTING SUFFICIENT DATA FOR DETERMINATION OF 300-DAY WORKERS, YEAR ENDING JUNE 30, 1910.

Plant number.	Positions shown on pay rolls.	300-day workers.	Number of accidents.			
			Fatal.	Permanent injury.	Temporary disability, 1 day and over.	Total.
3	2,447	2,348	.....	1	46	47
9	904	931	.....	8	87	95
11	187	123	.....	.....	14	14
13	269	245	.....	.....	31	31
14	739	725	.....	2	17	19
18	438	453	1	2	62	65
19	313	340	.....	.....	16	16
20	837	633	1	.....	69	70
22	465	477	.....	1	19	20
45	372	365	.....	1	11	12
48	587	597	.....	2	35	37
49	117	117	.....	.....	40	40
53	630	586	.....	.....	66	66
61	263	268	.....	.....	50	50
68	112	101	.....	.....	36	36
103	510	505	.....	.....	127	127
104	229	231	1	1	26	28
116	142	142	.....	.....	28	28
121	355	306	1	2	108	111
122	2,189	2,361	2	4	341	347
123	183	134	.....	2	38	40
124	470	414	.....	.....	10	10
125	487	516	.....	2	46	48
126	146	123	.....	1	34	35
127	882	867	1	2	407	410
128	758	642	.....	4	194	198
149	124	114	.....	.....	16	16
150	549	538	.....	1	39	40
151	236	218	1	.....	31	32
152	709	607	.....	.....	33	33
153	293	292	.....	1	71	72
154	106	69	.....	.....	1	1
155	97	92	.....	.....	4	4
Total	17,145	16,480	8	37	2,153	2,198
Rate per 1,000 300-day workers	.....	.....	0.49	2.25	130.6	133.4

In the general investigation it was not the original intention to include the steel foundries, but, inasmuch as many of them make steel as well as cast it, returns were received from a considerable portion of this department of the industry. There were also returns with regard to accidents from a number of establishments which do not make steel, but were associated with rolling mills or other departments included in the general investigation. It seems desirable, therefore, to bring together the available data concerning accidents in the foundries. Since these are not discussed in any other connection, the facts regarding them are presented more fully than have been those with regard to other departments.

The hazards of steel foundries seem to be mainly related to two operations—(1) the handling of the molten metal and (2) the moving

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of heavy castings and other articles. The rates shown are as follows: Fatal accidents, 0.49 per 1,000; permanent injury, 2.25; temporary disability, 130.6; total, 133.4. These rates are, on the whole, decidedly lower than those observable in other departments. The permanent injuries nearly all arise in connection with the handling of hot metal. The metal is reduced to a molten state, either in a cupola, where the heat is produced by the combustion of coke in contact with the metal, or in an open-hearth furnace heated with gas flames. In either case, where the metal is tapped out of the furnace, there is considerable danger of explosion and danger that the flying masses of molten steel may be of sufficient size to cause serious burns. Nearly all the fatal cases recorded were due to burns arising from an explosion either at this point or in the course of the transportation of the metal to the molds. An illustration of this danger, which has been mentioned elsewhere, may here be repeated: A ladle containing a large quantity of metal was being tilted to pour the contents. It had been raised from a pit dug in the ground for its reception. The location of the foundry was such that the soil contained considerable moisture, and this had at times caused difficulty by water leaking into this pit. To avoid this danger the pit had been given a boiler-plate lining, carefully made and supposedly water-tight. Whether the lining had sprung a leak or water had gotten into it in some other way is unknown, but the presence of water was probably due to unnoticed leakage. As the ladle was tipped either the operator of the tilting mechanism became confused or there was some unknown defect in the mechanism. He suddenly appeared to lose control of the ladle and abandoned his post. The ladle overturned, the contents falling into the pit. A terrific explosion followed, instantly killing the operator. The explosion was of such violence that the tile roof of the foundry was lifted clear from the walls, the walls were blown outward, and the roof fell upon the workmen below. It is probable that the operator of the ladle was the only one killed directly by the explosion, the other fatalities being due to the falling roof. The violence of the explosion, of course, destroyed the pit lining and so wrecked the mechanism of the ladle that it was impossible to determine the various conditions which may have contributed to the disaster. This case, while unlikely to be duplicated, indicates the nature of one of the hazards constantly besetting the handling of molten metal.

The temporary disabilities are due to two causes—bruises and crushing injuries connected with the moving of heavy flasks and castings, and minor burns, mostly of the feet. Where small castings are made the metal is handled in small ladles carried by the men, and an accidental splash of metal falling into or upon the shoe is quite likely to produce a more or less severe burn. It has not been possible

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in connection with this investigation to determine exactly whether the accident rate of foundries, while comparatively small, is capable of further reduction. The report of one of the agents of the Bureau upon a large foundry plant seems to indicate that many improvements are possible and that with them should go a still lower rate of accident. The following statements from the report in question are significant:

In the machine shops the floors were worn, the boards loose and broken to such an extent that the workmen were constantly liable to accident from tripping. The walls of the building were old and open and exposed the men to bad weather conditions. The buildings were crowded and littered with machinery and materials to an extent that was a constant menace. In the yards, together with piles of material, were accumulations of rubbish which might have been and should have been removed. It was reported that up to the fall of 1910 little or no attention had been given to safeguarding the employees against danger. At that time, under pressure, some changes were made in compliance with the factory laws of the State. No attempt to remove the dangerous conditions prevalent in the yards was apparent. Illustrating the general conditions prevalent in this foundry, the following may be instanced: In the shop where the patterns were made there were a number of pulleys running near the floor. A box had been built around these scarcely higher than the pulleys themselves, the belts extending up to the ceiling. Near the box lay a pile of scrap iron. The foreman's attention was called to the possibility of tripping over this pile of scrap and falling into the pulley box. The foreman stated that he did not know whether the box in question conformed with the State laws and knew of no reason why it should not be made high enough to protect a passer-by from the belting and a door arranged by which oiling would be possible.

This illustration is given at length because it is believed that it represents fairly the general condition in a considerable number of foundries. Their hazard has been so much less than that of other departments of the iron and steel industry that special attention has not been directed to them, and they undoubtedly remain in a condition much more hazardous than should be the case.

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SUMMARY.[1]

The following table gives a summary of the accidents and accident rates for the departments shown in the preceding tables:

SUMMARY OF ACCIDENTS IN DEPARTMENTS REPORTING SUFFICIENT DATA FOR DETERMINATION OF 300-DAY WORKERS, YEAR ENDING JUNE 30, 1910.

Departments.	300-day workers.	Number of injuries.				Accident rate per 1,000 300-day workers.			
		Fatal.	Permanent injury.	Temporary disability, 1 day and over.	Total.	Fatal.	Permanent injury.	Temporary disability, 1 day and over.	Total.
Blast furnaces	19,604	60	50	4,937	5,047	3.06	2.55	251.8	257.4
Bessemer steel works	3,668	16	11	1,525	1,552	4.36	3.00	415.8	423.1
Open-hearth steel works	9,017	30	38	2,999	3,067	3.33	4.21	332.6	340.1
Puddling	1,239			62	62			50.0	50.0
Rolling mills (mechanical)	13,566	28	40	4,131	4,199	2.06	2.95	304.5	309.5
Rolling mills (hand)	10,675	11	28	3,872	3,911	1.03	2.62	362.7	366.4
Mechanical	17,421	23	31	4,093	4,147	1.32	1.78	234.9	238.0
Yards	16,441	47	23	2,413	2,483	2.86	1.40	146.8	151.0
Steel foundries	16,490	8	37	2,153	2,198	.49	2.25	130.6	133.4
Departments not specified[1]	38,868	51	142	9,179	9,372	1.32	3.67	237.1	242.0
Total	146,979	274	400	35,364	36,038	1.86	2.72	240.6	245.2

[1] In addition to departments other than those specified in this column this group covers all departments in establishments for which data as to departments were not separately reported.

COMPARISON OF PLANTS AND DEPARTMENTS ACCORDING TO CHARACTER OF SAFETY SYSTEMS.

The purpose of this report throughout is to bring clearly and sharply to the attention of the reader the existing conditions as to accident occurrence and the need of improvement in methods and appliances tending to reduce accidents, and more important still to emphasize the possibilities of constructive effort. This will best be brought out in a study of the accident rates in plants which have well organized accident prevention systems in comparison with plants which have given little or no attention to the subject. The following table presents a classification of plants chosen from the general table for the purposes of this comparison according to the following plan:

First. The plants are composite; that is, each of th m incl des at least two of the productive departments.

Second. Each plant employs 1,000 or more 300-day workers, except one which falls below this limit by 25. Most of them have considerably over 1,000.

Third. The accident returns from these plants were all scrutinized with special care. In every case the methods of keeping these records and the probability of their accuracy were determined by personal investigation on the part of the agents of the Bureau.

For statistics of industrial accidents in the United States, see Bulletin of the U. S. Bureau of Labor, No. 78; for statistics of fatal accidents in coal mines, see Bulletin of the U. S. Bureau of Labor, No. 90.

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Fourth. The actual condition of the plants as affecting the hazard was determined by careful individual inspection and study of each plant. With but two exceptions this study was made by the writer and occupied for each plant a period of from three days up to several weeks.

It is believed that the four limitations suggested above and imposed in the selection of these plants for comparison renders the showing as exact and representative as it could possibly be made. The classes are based upon the degree of development found to exist in the safety systems in operation in these plants. In class A a safety system is well developed; in class B it is in process of development; in class C not developed. In this third class it is not the intention to assert that no efforts have been made in the direction of accident precaution, although in some instances such a statement would be without justification. Most of the managers of these plants are already conscious that effort in this direction is properly demanded of them and some of them have already initiated efforts.

COMPARISON OF ACCIDENT RATES IN PLANTS CLASSIFIED ACCORDING TO DEGREE OF DEVELOPMENT OF SAFETY SYSTEMS, YEAR ENDING JUNE 30, 1910.

Plants having safety systems of specified class.	300-day workers.	Number of accidents.				Accident rates per 1,000 300-day workers.			
		Fatal.	Permanent injury.	Temporary disability, 1 day and over.	Total.	Fatal.	Permanent injury.	Temporary disability, 1 day and over.	Total.
A. System well developed:									
Plant No. 120	975	.....	7	106	113	.....	7.18	108.7	115.9
Plant No. 59	6,137	4	15	862	881	0.65	2.44	140.4	143.5
Plant No. 104	6,225	20	11	969	1,000	3.21	1.77	155.7	160.6
Plant No. 103	7,642	12	5	1,270	1,287	1.57	.65	166.2	168.4
Plant No. 102	1,084	1	2	238	241	.92	1.85	219.6	222.3
Plant No. 101	2,348	5	4	548	557	2.13	1.70	233.4	237.2
Total	24,411	42	44	3,993	4,079	1.73	1.79	163.6	167.1
B. System in process of development:									
Plant No. 116	5,572	22	58	1,255	1,335	3.95	10.41	225.2	239.6
Plant No. 68	8,109	19	7	2,089	2,115	2.34	.86	257.6	260.8
Plant No. 66	4,185	11	5	1,157	1,173	2.63	1.19	276.5	280.3
Plant No. 133	6,833	14	25	1,941	1,980	2.05	3.66	284.1	289.8
Plant No. 99	4,131	7	10	1,232	1,249	1.69	2.42	298.2	302.3
Total	28,830	73	105	7,674	7,852	2.53	3.64	266.2	272.4
C. System not developed:									
Plant No. 145	1,491	7	5	589	601	4.69	3.35	395.0	403.1
Plant No. 127	1,131	1	2	478	481	.88	1.77	422.6	425.3
Plant No. 80	1,272	2	1	549	552	1.57	.79	431.6	434.0
Plant No. 132	9,726	24	25	5,095	5,144	2.47	2.57	523.9	528.9
Plant No. 81	1,296	3	1	794	798	2.31	.77	612.7	615.7
Total	14,916	37	34	7,505	7,576	2.48	2.28	503.2	507.9

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It is desirable to define somewhat carefully at this point the elements which determine the classification in each group. The essentials of a safety system likely to prove effective may be summarized as follows. In plants of class A all the factors specified are present:

1. Safeguarding by signs, warnings, and mechanical contrivances.
2. Adequate safety inspection.
3. Safety committees of superintendents and foremen.
4. Safety committees of workmen.
5. Emergency and hospital care of the injured.
6. A compensation system.
7. Provision for the permanently disabled.

Some comment is necessary on these items. A first step toward reduced accident rates is the correction of all conditions which thorough scrutiny indicates to be dangerous. This is a much less difficult task than many plant managers believe. It costs money and time and effort, but in a comparatively brief period a plant can be brought to the standard of our present knowledge. As knowledge increases and new conditions develop there will be further demands upon mechanical ingenuity.

The inspection system varies with the size of the plant, but must always be given competent leadership sufficiently independent of the operating departments. Unless this independence is provided the safety department is unable to carry out its ideas.

The organization of a plant committee of superintendents is highly important. Otherwise the operating heads, whether superintendents or foremen, fail to come into active and aggressive sympathy with the movement. Nearly all such officers up to the time when the movement became strong held the idea that accidents were mainly of two characters, unavoidable incidents of industrial production or the result of a sort of carelessness which no education could remove. The only successful method so far devised to bring this essential element to the support of the movement has been the safety committee.

Committees of workmen form the basis of an educational effort necessary to far-reaching success.

The foregoing are most directly related to satisfactory results. The other items mentioned have a more indirect bearing, but are none the less important.

In class B some of the measures characteristic of class A have already been introduced; in some cases all of them are in operation. Owing to the absence of some of the essential elements or to the fact that those which have been introduced have not been long enough in operation, complete results have not yet been secured.

In class C practically only one of these various necessary things has been even begun. Some of the plants in this group have installed

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to a partial degree safety devices. Since this is, after all, a rather small part of what is necessary to the securing of results, class C must be regarded as exceedingly deficient.

As before stated, these facts with regard to the different plants were carefully ascertained, and the classification of the plants was made prior to the calculation of rates. This statement is made in order to call attention to the rather remarkable correspondence of these rates to the conditions disclosed in the plants on the basis of which the classification was made. The arrangement within each class was determined after the calculation of rates, they being placed in order from lowest to highest with reference to their general accident rate.

It will be observed that the least satisfactory member of each group has a considerably lower rate than the best plant in the following group. The attempt was to assemble groups of plants having certain characteristics, and the results of these assemblages were very likely to overlap, as suggested. The margin between the last plant in class A and the first plant in class B is not very wide. Plant 101 in class A has a rate of 237.2, while plant 116 in class B has a rate of 239.6. A slight change in the relations of these two would have brought about an overlapping.

The rates for fatality and permanent injury appear to be a little contradictory, and therefore an explanatory statement is necessary. The fatality rates are: Class A, 1.73; class B, 2.53; class C, 2.48. That class C should have a lower fatality rate than class B would appear to be contradictory. The explanation lies in two facts: First, that plant 116 of class B, while actively engaged in efforts toward safety, was during the year in question especially unfortunate in the number of its fatalities. But one other plant in the three classes has a greater number of fatalities, and only one other has a higher rate. On the other hand, in class C several plants, while showing an exceedingly unsatisfactory situation in general accidents, were fortunate enough in the year under consideration to escape with few fatalities. In permanent injury the rates are: Class A, 1.79; class B, 3.64 class C, 2.28. The same explanation of the higher rate in class B that has been given for the fatality rates applies to these permanent injuries. It is pertinent at this point to refer to the statements made in the section on the significance of fatality rates.[1] The general accident rate is a much fairer basis of comparison for a single year, and where there is contradiction between it and the fatality or permanent disability rate, the general accident rate should be assumed to represent more accurately the real conditions. In the classes under consideration this general accident rate is: Class A, 167.1; class B, 272.4; class C, 507.9. Class A does not represent the best results

[1] See pp. 90 and 91.

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possible to be attained by well-directed safety effort, but represents the average which has been secured among certain plants which have adequately undertaken the task. Class C must be taken to represent a condition which was practically universal in the iron and steel industry not many years ago. The relation between the rates in these two classes may fairly be regarded as indicating the degree to which accidents may, and therefore ought to be, reduced. Class A has not yet gone to the limit. Class C has scarcely begun.

Another possibility deserves consideration. Perhaps the year chosen was one of unusual misfortune in the plants of class C. If that were true, the position assigned them might be seriously unfair. Since rates are not possible for 1909 because the number of 300-day workers can not be determined, the number of accidents only can be compared. The plants in class A had 2,534 in 1909 and 4,079 in 1910; those of class B 4,364 in 1909 and 7,852 in 1910, and those in class C 5,227 in 1909 and 7,576 in 1910. These figures indicate that the classification of 1910 is applicable in 1909 and that no injustice has been done to the plants of class C.

Various estimates have been offered with regard to the degree to which industrial accidents may be decreased. In an industry like iron and steel, where the hazard is admittedly among the highest, these possibilities of decrease are necessarily the greatest. We have in these figures not an estimate but a positive demonstration of what can be accomplished in this industry in the way of accident decrease. The accident rate of class A is only 33 per cent of that of class C. In making this comparison it should be remembered that the main decrease was in accidents causing temporary disability, the rates for such accidents in Class A being 67 per cent less than those in Class C, while for fatal and permanent injuries combined the rates were only 26 per cent less.

An entirely appropriate question and one which should be answered with great candor is: Are these reductions possible in all plants? Do the plants of class C represent industrial conditions so different from those of class A that the comparison which has been made between them is an unjust one? The answer is: The conditions are absolutely comparable and nothing which has been done in plants of class A is in the smallest degree impossible in those of class C. The plants in each of the three groups under consideration consist individually of blast furnaces, steel works, and rolling mills. It is a fact that several of the plants of class A began the movement for safety under conditions even more discouraging than those which now exist in class C. The entire difference between those classes is due to the methods of the management and not at all to necessary differences of industrial condition. It is therefore by no means too strong a statement to say that any one of the plants in class C could

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reach in a period of from 3 to 5 years the same position as to accidents now occupied by those of class A.

In making this statement it should not be understood that the task is an easy or an inexpensive one. The plants of class A and class B have spent, and are spending, very large sums to secure their results. They are also spending time and thought and effort on the part of their managers. Those plants whose condition is not satisfactory—and there are some few that are probably even worse than any presented in class C—are in a position of great advantage for the rapid reduction of their accident rate. The pioneer work has been done. The methods of the movement have become standardized. Numbers of manufacturers have been so influenced by the progress of the movement that they have re-formed the designs of their machines and now produce apparatus in which many of the dangers against which the pioneers of the movement have had to contend are eliminated. All these things being true, it is clearly within reason to say that a period no longer than the one mentioned above is all that is necessary for any plant which undertakes the matter with thoroughness and determination to achieve satisfactory results. No small element in this possibility is the fact that there has grown up in connection with the development of this movement a group of safety men who are devoting themselves enthusiastically to the needed work and who may be drawn upon by those plants which recognize that their present status is indefensible.

The preceding section has shown the results of the development of safety systems when considered by plants as a whole. It is desirable to analyze these results along another line. It is possible, of course, that the figures shown in the preceding section depend upon some extraordinary results in a single department and that there are other departments in which no such results have been attained or are possible. The following table has been prepared in order to reply to questions of this sort which may naturally arise.

In the preparation of this table the same general method was pursued as in the one just discussed; that is, departments were chosen upon the basis of knowledge regarding the conditions prevalent in them. Some limitations due to the nature of the available material must be noticed: (1) Some large plants used in the preceding table were not available for this since it was impossible to separate their departments satisfactorily; (2) plants which were not usable in the first table because they were too much below 1,000 in the number of 300-day workers, or because they had too few departments, could be utilized here by uniting their departments into sufficiently large groups. The result of this necessary diversity of the materials available for the two tables accounts for the differences which exist between them.

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COMPARISON OF ACCIDENT RATES IN DEPARTMENTS CLASSIFIED ACCORDING TO DEGREE OF DEVELOPMENT OF SAFETY SYSTEMS, YEAR ENDING JUNE 30, 1910.

Departments having safety systems of specified class.	300-day workers.	Number of accidents.				Accident rates per 1,000 300-day workers.			
		Fatal.	Permanent injury.	Temporary disability, 1 day and over.	Total.	Fatal.	Permanent injury.	Temporary disability, 1 day and over.	Total.
A. System well developed:									
Blast furnaces	2,107	6	1	393	400	2.85	0.47	186.5	189.8
Steel works	2,028	7	3	626	636	3.45	1.48	308.7	313.6
Rolling mills	4,504	10	7	988	1,005	2.22	1.55	219.4	223.1
Mechanical	3,962	2	4	385	391	.50	1.01	97.2	98.7
Yards	2,882	10	3	352	365	3.47	1.04	122.1	126.6
Total	15,483	35	18	2,744	2,797	2.26	1.16	177.2	180.6
B. System in process of development:									
Blast furnaces	2,163	3	3	479	485	1.39	1.39	221.5	224.2
Steel works	3,123	14	7	1,164	1,185	4.48	2.24	372.7	379.4
Rolling mills	3,928	4	6	1,315	1,325	1.02	1.53	334.8	337.3
Mechanical	3,250	5	4	894	903	1.54	1.23	275.1	277.8
Yards	2,051	7	.....	388	395	3.41	.....	189.2	192.6
Total	14,515	33	20	4,240	4,293	2.27	1.38	292.1	295.8
C. System not developed:									
Blast furnaces	2,208	7	9	769	785	3.17	4.08	348.3	355.5
Steel works	2,053	9	14	1,196	1,219	4.38	6.82	582.6	593.8
Rolling mills	4,928	12	31	2,056	2,099	2.44	6.29	417.2	425.9
Mechanical	4,855	5	19	1,834	1,858	1.03	3.91	377.8	382.7
Yards	2,993	12	12	826	850	4.01	4.01	276.0	284.0
Total	17,037	45	85	6,681	6,811	2.64	4.99	392.1	399.8

It will be noticed that the general accident rates increase from class to class for each department. For the smaller and more fluctuating groups of fatal and permanent injuries this is not always the case and should not be expected to be.

The relation of the classes as a whole is not so well shown in this table as in that by plants, since the necessary limitations of the groups, pointed out above, makes them less authoritative for that purpose.

This presentation clearly demonstrates that the results of safety effort are not confined to departments where conditions are particularly favorable but that they are found in all departments. The degree of success is not uniform, but there is success everywhere. It can not therefore be argued that safety methods are only useful in certain restricted areas or occupations and do not have general application. The evidence all points to a pervasive improvement affecting the entire plant, department by department. Even those departments where the difficulty is greatest have been at least started in the right direction and are securing results.

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DURATION OF DISABILITY.

The table on page 43 makes it possible to compare the relative hazards of the departments of the industry as shown by the rates. It is now desirable to inquire whether any other factors should be considered in reaching a final conclusion. It is clear that without considering the severity of the accidents an exact measure of the relative position has not been reached. Two methods of securing some knowledge of severity suggest themselves: (1) The percentage of cases falling in each disability period may be determined; (2) the average duration of disability may be taken as a measure.

DISABILITIES TERMINATING IN SPECIFIED WEEK.

The accompanying table aggregates the disabilities terminating in each week from the first to the fifth and in the sixth and later. Their distribution is shown both in the form of percentages and in the form of rates.

COMPARISON OF DEPARTMENTS, SHOWING DISABILITIES OF SPECIFIED CHARACTER AND DURATION, YEAR ENDING JUNE 30, 1910.

[The figures in this table are for those departments only which reported data sufficient for determination of 300-day workers, together with week in which temporary disabilities terminated.]

NUMBER OF DISABILITIES.

Departments.	Number of establishments.	300-day workers.	Total nonfatal injuries.	Permanent injuries.	Temporary disabilities (1 day and over) terminating in specified week.					
					First.	Second.	Third.	Fourth.	Fifth.	Sixth and later.
Blast furnaces	27	10,522	3,350	20	1,747	762	331	122	126	242
Steel works	21	10,000	4,008	34	1,926	895	430	258	183	277
Rolling mills	42	19,040	6,957	53	3,453	1,667	700	361	295	428
Mechanical	25	14,620	3,448	25	1,896	705	301	196	125	200
Yards	23	10,965	1,700	17	867	404	153	77	78	104
Total	(1)	65,147	19,458	149	9,889	4,433	1,915	1,014	807	1,251

PER CENT IN EACH CLASS.

Blast furnaces	27	10,522	100.0	0.6	52.1	22.7	9.9	3.6	3.8	7.2
Steel works	21	10,000	100.0	.8	48.1	22.4	10.7	6.4	4.6	6.9
Rolling mills	42	19,040	100.0	.8	49.6	24.0	10.1	5.2	4.2	6.2
Mechanical	25	14,620	100.0	.7	55.0	20.4	8.7	5.7	3.6	5.8
Yards	23	10,965	100.0	1.0	51.0	23.8	9.0	4.5	4.6	6.1
Total	(1)	65,147	100.0	.8	50.8	22.8	9.8	5.2	4.1	6.4

RATES PER 1,000 300-DAY WORKERS IN EACH CLASS.

Blast furnaces	27	10,522	318.4	1.9	166.0	72.4	31.5	11.6	12.0	23.0
Steel works	21	10,000	400.3	3.4	192.6	89.5	43.0	25.8	18.3	27.7
Rolling mills	42	19,040	365.4	2.8	181.4	87.6	36.8	19.0	15.5	22.5
Mechanical	25	14,620	235.8	1.7	129.7	48.2	20.6	13.4	8.5	13.7
Yards	23	10,965	155.0	1.6	79.1	36.8	14.0	7.0	7.1	9.5
Total	(1)	65,147	298.7	2.3	151.8	68.0	29.4	15.6	12.4	19.2

[1] The total number of establishments can not be ascertained by adding the items, since many establishments have several departments.

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Knowledge of the different departments would suggest that they differ to such an extent that some of them would show a markedly greater proportion of the disabilities which terminate in the first week than others; but the table shows that no department varies widely from the average. The percentages of the first week are as follows: Blast furnaces, 52.1 per cent; steel works, 48.1 per cent; rolling mills, 49.6 per cent; mechanical, 55.0 per cent; yards, 51.0 per cent; average, 50.8 per cent.

In the following table facts similar to those just presented are brought out for a single large plant for a period of six years:

COMPARISON OF DEPARTMENTS SHOWING DISABILITIES OF SPECIFIED CHARACTER AND DURATION IN A PLANT EMPLOYING AN AVERAGE OF 6,624 MEN, SIX YEARS ENDING DECEMBER 31, 1910.

NUMBER OF DISABILITIES.[1]

Departments.	300-day workers.	Total non-fatal injuries.	Permanent injuries.	Temporary disabilities (1 day and over) terminating in specified week.					
				First.	Second.	Third.	Fourth.	Fifth.	Sixth and later.
Blast furnaces	6,608	1,625	13	704	301	182	115	97	213
Steel works	5,503	1,357	12	504	256	170	139	78	198
Rolling mills	10,259	1,763	20	733	356	186	124	124	220
Mechanical	5,625	1,003	9	535	180	92	48	35	104
Yards	4,586	846	7	393	144	87	57	55	103
Total	32,581	6,594	61	2,869	1,237	717	483	389	838

PER CENT IN EACH CLASS.

Blast furnaces	6,608	100.0	0.8	43.3	18.5	11.2	7.1	6.0	13.1
Steel works	5,503	100.0	.9	37.1	18.9	12.5	10.2	5.7	14.6
Rolling mills	10,259	100.0	1.1	41.6	20.2	10.6	7.0	7.0	12.5
Mechanical	5,625	100.0	.9	53.3	18.0	9.2	4.8	3.5	10.4
Yards	4,586	100.0	.8	46.5	17.0	10.3	6.7	6.5	12.2
Total	32,581	100.0	.9	43.5	18.8	10.9	7.3	5.9	12.7

RATES PER 1,000 300-DAY WORKERS IN EACH CLASS.

Blast furnaces	6,608	245.9	2.0	106.5	45.6	27.5	17.4	14.7	32.4
Steel works	5,503	246.6	2.2	91.6	46.5	30.9	25.3	14.2	35.6
Rolling mills	10,259	171.8	1.9	71.4	34.7	18.1	12.1	12.1	21.4
Mechanical	5,625	178.3	1.6	95.1	32.0	16.4	8.5	6.2	18.5
Yards	4,586	184.5	1.5	85.7	31.4	19.0	12.4	12.0	22.5
Total	32,581	202.4	1.9	88.1	38.0	22.0	14.8	11.9	25.7

[1] 348 cases, for which length of disability was not reported, are not included in this table.

Comparing the table just presented with the preceding table relating to all plants reported in 1910, it is seen that for the years 1905 to 1910 in the single large plant the percentages of temporary disabilities terminating in the first week were uniformly lower in each of the five departments than in the same departments for the industry as a whole in 1910, but on the other hand the percentages terminating in the sixth week and later were much larger than in the industry as a

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whole.[1] The general accident rate per 1,000 300-day workers was lower in the single plant and the rates were lower for disabilities terminating in each of the weeks except the sixth and later, when they were considerably higher. It would appear, then, that with a decreasing accident rate the less severe accidents occurring in the early weeks were reduced more rapidly than those causing disability terminating in the sixth week and later.

Inasmuch as this represents the experience of six years in a plant in which organized safety work was being developed, the relation of the general accident rate to disabilities terminating in specified weeks will be more clearly understood when the accident experience in this plant from year to year is studied.

LOSS OF TIME, BY DEPARTMENTS.

Under the present heading it is possible to consider the subject of loss of time from a slightly different angle. Appendix B presents in detail the ascertainable facts with regard to this subject. The information is there given both by departments and by occupations. Of the total injuries occurring in one group of 130 mills in the two years ending June 30, 1910, the amount of lost time is reported for 11,702 cases. The following table presents for each department the

[1] Elsewhere attention has been called to the fact that the only figures so far published which appear to be comparable with these are the figures of the Russian Imperial Insurance office. In the Twenty-fourth Annual Report of the Commissioner of Labor, Vol. II, p. 2195, will be found a tabulation of the accidents occurring in all industries in Russia in the years 1904, 1905, and 1906. This table does not include the disabilities terminating at three days and under. In order to render its figures comparable with those presented in this report, the first week must be disregarded and comparison made for the later weeks. The tabulation herewith presented shows that for the three years the percentage of accident in the second and succeeding weeks is similar to that disclosed by the American figures.

COMPARISON OF AMERICAN AND RUSSIAN DATA AS TO DURATION OF TEMPORARY DISABILITIES (NOT INCLUDING DISABILITIES TERMINATING IN FIRST WEEK).

	Temporary disabilities terminating in specified week.					Total.
	Second.	Third.	Fourth.	Fifth.	Sixth and later.	
RUSSIA.						
All industry for three years, as reported by Russian Insurance Office:						
Number	38,667	19,551	10,930	7,167	15,397	91,712
Per cent	42.2	21.3	11.9	7.8	16.8	100.0
UNITED STATES.						
Iron and steel industry in part for two years:						
Number	4,433	1,915	1,014	807	1,251	9,420
Per cent	47.0	20.3	10.8	8.6	13.3	100.0

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number of reported cases, the total days lost, and the average days lost per injury:

AVERAGE DAYS LOST PER INJURY IN SPECIFIED DEPARTMENTS OF 130 PLANTS, TWO YEARS ENDING JUNE 30, 1910.

[It should be noted that the groups of less than 200 are so small that they do not have much significance.

Departments.	Injuries for which time lost was reported.	Days lost.	
		Total.	Average per injury.
Blast furnaces	1,317	17,544	13.3
Steel works	990	14,048	14.2
Rolling mills	2,033	24,744	12.2
Tube mills	462	7,411	16.0
Sheet mills	252	3,063	12.2
Mechanical	1,248	16,196	13.0
Yards	1,443	20,304	14.1
Foundries	1,283	12,769	10.0
Electrical	76	1,663	22.0
Boiler houses and engine rooms	237	3,309	14.0
Crucible furnaces	101	1,930	19.1
Forge shops	136	1,476	10.9
Puddling	122	2,675	21.9
Wire mills	308	3,671	11.9
Miscellaneous	744	10,671	14.3
Not reported	950	9,383	9.9
Total	11,702	150,857	12.9

In this table appears the average loss per injury for each of the departments. The table discloses in a measure the degree of severity of injuries in each department, but the figures can not be used as a basis for ranking the departments with regard to hazard, because the number of 300-day workers is not available and the frequency of accidents to workers in the several departments as shown by the rates per 1000 300-day workers can not be determined.

Consideration of the duties of electrical workers, especially linemen, suggests the possibility of severe injury. They must from time to time deal with currents of high intensity. They also work often at high elevations where a mild shock, not injurious in itself, might cause a fall. It appears reasonable to suppose that the prolonged disability shown in the table, while not conclusive since it pertains to so small a group, represents one phase of their danger.

It is possible further to present the matter just considered on the basis of the single plant which has already been used for comparative purposes. For this plant the total number of days lost from disabilities, classified according to week of termination, were ascertained for the 5 principal departments. The figures are presented in the following table in three forms: First, the total number of days lost; second, the percentage of loss in each class; and third, the average days lost per injury in each class.

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COMPARISON OF DEPARTMENTS, SHOWING DAYS LOST ON ACCOUNT OF DISABILITIES OF EACH SPECIFIED DURATION IN A PLANT EMPLOYING AN AVERAGE OF 6,624 MEN, SIX YEARS ENDING DECEMBER 31, 1910.

DAYS LOST.

Departments.	300-day workers.	Total days lost.	Days lost through disabilities terminating in specified week.					
			First.	Second.	Third.	Fourth.	Fifth.	Sixth or later.
Blast furnaces	6,608	32,467	2,672	3,182	3,258	2,878	3,027	17,450
Steel works	5,503	29,807	1,991	2,737	3,057	3,470	2,459	16,093
Rolling mills	10,259	33,941	2,787	3,780	3,344	3,071	3,922	17,037
Mechanical	5,625	15,639	1,903	1,906	1,673	1,214	1,029	7,914
Yards	4,586	15,217	1,455	1,524	1,517	1,407	1,752	7,562
Total	32,581	127,071	10,808	13,129	12,849	12,040	12,189	66,056

PER CENT OF DAYS LOST IN EACH CLASS.

Blast furnaces	6,608	100.0	8.2	9.8	10.0	8.9	9.3	53.7
Steel works	5,503	100.0	6.7	9.2	10.3	11.6	8.2	54.0
Rolling mills	10,259	100.0	8.2	11.1	9.8	9.0	11.5	50.2
Mechanical	5,625	100.0	12.2	12.2	10.7	7.8	6.6	50.6
Yards	4,586	100.0	9.6	10.0	10.0	9.2	11.5	49.7
Total	32,581	100.0	8.5	10.3	10.1	9.5	9.7	52.0

AVERAGE DAYS LOST PER INJURY IN EACH CLASS.

Blast furnaces	6,608	20	4	11	18	25	31	77
Steel works	5,503	22	4	11	18	25	32	77
Rolling mills	10,259	19	4	11	18	25	32	69
Mechanical	5,625	16	4	11	18	25	32	70
Yards	4,586	18	4	11	17	25	32	69
Total	32,581	19	4	11	18	25	32	73

Considering the per cent of total days lost in each period, it is found that the condition is the reverse of that shown for the number of injuries. The number of injuries decreases steadily throughout the successive groups. The percentages of loss were as follows: From disabilities terminating in the first week, 8.5 per cent; in the second, 10.3 per cent; third, 10.1 per cent; fourth, 9.5 per cent; fifth, 9.7 per cent; and sixth and later, 52.0 per cent. It will be noticed that for the five departments as a whole there is little variation in the per cent of total days lost for the four weeks following the first.

The fact of greatest economic significance here is that the total time lost from the disabilities terminating before the sixth week (nearly 90 per cent in number of all temporary disabilities) was only 48 per cent of the total time lost from temporary disabilities. When the economic losses from fatal accidents and from permanent disablements are also considered, the relative importance of the losses from short term disabilities would be greatly diminished.

It has been noted already that the mechanical department shows a higher percentage of disability terminating in the first week than any of the other departments. This is true both in the table on

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page 50 and that on page 51. With a high percentage of injuries there appears for the mechanical department a high percentage of lost time in the early periods. For this department the losses run as follows: First week, 12.2 per cent; second week, 12.2 per cent; third week, 10.7 per cent; fourth week, 7.8 per cent; fifth week, 6.6 per cent.

It will be noticed that for each department the average days lost per injury during the 6 years in the single plant are considerably higher than the averages for the same departments of the 130 plants in 1909 and 1910. This does not indicate a greater prevalence of severe injury but is due to the fact that minor accidents decline more rapidly under organized safety effort than serious ones, and the result is a higher average duration per injury.

It is of interest to know the average amount of time lost annually per worker from accidents in the principal departments of all the plants under consideration. To ascertain this, data are necessary both for total time lost and for total number of 300-day workers. As already indicated, the total time lost is reported for injuries occurring in 130 plants during the years ending June 30, 1909 and 1910, and in one large plant for the years ending December 31, 1905 to 1910, but data were not available for the determination of 300-day workers for these periods and plants, according to the method explained on pages 21 and 22. It is possible, however, to estimate with approximate accuracy the number of 300-day workers, and this is done by the following method.

By combining the available data for the plants reporting number of accidents for the year ending June 30, 1910, with those for the large plant reporting these items for the calendar years 1905 to 1910, the total number of 300-day workers and of injuries involving temporary disability are ascertained,[1] and the accident rates as shown in the following table are found. It is assumed that the relation between workers and accidents expressed by these rates also prevails in plants for which time lost from injuries was reported, but for which 300-day workers could not be determined. Dividing the number of injuries in such plants, shown in the next to the last column of the table, by the accident rates, the calculated number of 300-day workers for each department, shown in the last column, are secured.

[1] For these data see tables, pp. 43 and 119 and Appendix D.

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CALCULATED NUMBER OF 300-DAY WORKERS IN SPECIFIED DEPARTMENTS OF PLANTS REPORTING TOTAL DAYS LOST FROM INJURIES.

Departments.	Data for plants for which number of 300-day workers could be determined.[1]			All injuries for which time lost was reported.[2]	Calculated number of 300-day workers.
	Number of 300-day workers.	Injuries involving temporary disability, 1 day and over.			
		Number.	Rate per 1,000 300-day workers.		
Blast furnaces	26,212	6,628	253	2,942	11,628
Steel works	18,188	5,946	327	2,347	7,077
Rolling mills	34,500	9,858	286	3,796	13,273
Foundries	18,768	2,523	134	1,645	12,276
Mechanical	23,046	5,117	222	2,251	10,140
Yards	21,027	3,300	157	2,289	14,580

[1] Figures cover combined data for the year ending June 30, 1910, and in the case of 1 large plant the 6 years ending Dec. 31, 1910. See tables on pp. 43 and 119 and Appendix D.
[2] Figures cover combined data for the 2 years ending June 30, 1910, and in the case of 1 large plant the 6 years ending Dec. 31, 1910. See Appendixes B and F.

Dividing the reported number of days lost by the calculated number of 300-day workers gives the estimated average yearly loss in days per 300-day worker shown in the table which follows:

ESTIMATED AVERAGE NUMBER OF DAYS LOST ANNUALLY PER 300-DAY WORKER IN SPECIFIED DEPARTMENTS OF PLANTS REPORTING TOTAL DAYS LOST.

	Blast furnaces.	Steel works.	Rolling mills.	Foundries.	Mechanical.	Yards.
Calculated number of 300-day workers	11,628	7,077	13,273	12,276	10,140	14,580
Reported number of days lost[1]	50,011	43,855	56,685	21,467	31,835	35,521
Average yearly loss in days per 300-day worker	4.30	6.20	4.42	1.75	3.14	2.44

[1] Figures cover combined data for the 2 years ending June 30, 1910, and in the case of 1 large plant the 6 years ending Dec. 31, 1910. See tables on pp. 53 and 124.

This table indicates that the highest average number of days lost per 300-day worker was in the steel works, followed in order by rolling mills, blast furnaces, mechanical operations, yards, and foundries.

Tables which have already been given have indicated that with a decreasing accident rate there is a considerable fluctuation in the proportion of minor accidents and of those of a more serious character, with a tendency to a more rapid decrease in the accidents of short duration than in those involving a longer period of disability. The relation between a declining accident rate resulting from organized safety work extending over a period of years in the same establishment and the average days lost per injury, as well as the average days lost per 300-day worker, may be studied in the records of one plant where complete data are available for each of the six years, 1905 to 1910. The following table presents in comparative form the results of this experience:

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ACCIDENT RATES PER 1,000 300-DAY WORKERS AND AVERAGE DAYS LOST PER INJURY AND PER 300-DAY WORKER IN THE PRINCIPAL DEPARTMENTS OF A PLANT EMPLOYING AN AVERAGE OF 6,624 MEN, BY YEARS, 1905 TO 1910.

	1905	1906	1907	1908	1909	1910
Blast furnaces:						
Nonfatal injuries	406	399	314	191	213	181
Loss of time in days	5,400	6,834	8,116	5,156	3,339	3,622
Average days lost per injury	13.3	17.1	25.8	27.0	15.7	20.0
Nonfatal-accident rates per 1,000 300-day workers	422	316	267	192	188	167
Average days lost per 300-day worker	5.62	5.42	6.90	5.19	2.94	3.35
Steel works:						
Nonfatal injuries	267	271	335	119	225	217
Loss of time in days	4,187	6,196	7,462	1,835	4,778	5,349
Average days lost per injury	15.7	22.9	22.3	15.4	21.2	24.6
Nonfatal-accident rates per 1,000 300-day workers	361	276	285	236	232	191
Average days lost per 300-day worker	5.66	6.22	6.35	4.64	4.94	4.72
Rolling mills:						
Nonfatal injuries	348	401	357	168	309	293
Loss of time in days	4,348	7,646	7,196	3,658	5,545	5,548
Average days lost per injury	12.5	19.1	20.2	21.8	17.9	18.9
Nonfatal-accident rates per 1,000 300-day workers	249	237	190	149	174	123
Average days lost per 300-day worker	3.11	4.52	3.83	3.24	3.12	2.32
Mechanical:						
Nonfatal injuries	415	186	182	73	76	102
Loss of time in days	5,166	2,599	3,153	1,660	1,423	1,638
Average days lost per injury	12.4	14.0	17.3	22.7	18.7	16.1
Nonfatal-accident rates per 1,000 300-day workers	381	162	158	116	107	113
Average days lost per 300-day worker	4.75	2.27	2.74	2.64	2.00	1.82
Yards:						
Nonfatal injuries	290	199	146	60	94	105
Loss of time in days	3,862	3,872	3,062	889	1,687	1,845
Average days lost per injury	13.3	19.5	21.0	14.8	17.9	17.6
Nonfatal-accident rates per 1,000 300-day workers	245	175	156	169	234	182
Average days lost per 300-day worker	3.26	3.41	3.28	2.50	4.20	3.23
Total, 5 departments:						
Nonfatal injuries	1,726	1,456	1,334	611	917	898
Loss of time in days	22,963	27,147	28,989	13,198	16,772	18,002
Average days lost per injury	13.3	18.6	21.7	21.6	18.3	20.0
Nonfatal-accident rates per 1,000 300-day workers	321	234	211	169	184	148
Average days lost per 300-day worker	4.28	4.37	4.59	3.66	3.36	2.96

The above table presents a condensed history of the progress of accident prevention in the plant whose experience is analyzed in detail in Chapter II. The salient feature of this table is the steady and considerable fall in the accident rates per one thousand 300-day workers and in lost time per 300-day worker. These figures furnish two measures of improvement in conditions in this period of six years. Between 1905 and 1910, taking the five principal departments of this plant together, the accident rate per one thousand 300-day workers fell from 321 to 148, or 57 per cent, while the average days lost per 300-day worker fell from 4.28 to 2.96, or 31 per cent.

It will be observed that the per cent of decline in the rate per one thousand 300-day workers was greater than the per cent of decline in the average days lost, and this is true for each of the five departments shown in the above table. The explanation of this more rapid decline in the accident rates than in the days lost is that the

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minor accidents decrease more rapidly than do those of a more severe character. This has previously been indicated in the comparison between plants with developed safety systems and those which have done little or no work of that character. A very great number of the minor injuries are of a nature which a little care and foresight will prevent. On the other hand, an important feature of the severe accidents is the fact that they can not be foreseen and are not, therefore, so readily diminished by safety measures.

From the fact that with safety effort the accident rate per one thousand 300-day workers declines more rapidly than does the average days lost per 300-day worker, it follows that under these circumstances the average days lost per injury will increase, and it will be seen that in the above table this is what uniformly took place in each of the five departments covered. These figures, it should be pointed out, do not indicate a greater prevalence of serious injury, but merely that the short disability accidents declining more rapidly than those of a serious character the average duration of each injury is somewhat longer.

LOSS OF TIME, BY OCCUPATIONS.

The following table brings out the liability of the occupations to various degrees of severity in their injuries.

COMPARISON OF TYPICAL STEEL-PLANT OCCUPATIONS, BY NUMBER OF DAYS LOST PER INJURY.

[Figures are for 130 plants for 2 years ending June 30, 1910, and for 1 plant for 6 years ending Dec. 31, 1910 For details see Appendixes B and F.]

Occupation.	Number of injuries.	Days lost.	
		Total.	Average per injury.
Oilers and greasers	165	4,224	26
Crane hookers	249	5,631	23
Switchmen	379	7,487	20
Ladle men, steel works	214	4,329	20
Laborers, steel works	973	18,167	19
Cast-house crew [1]	481	9,250	19
Cranemen	182	3,092	17
Stockers, blast furnaces [2]	282	4,767	17
Laborers, blast furnaces	1,315	20,802	16
Laborers, rolling mills	1,699	27,747	16
Laborers, yards	1,648	23,669	14
Mechanics [3]	1,299	17,607	14
Rolling crew [4]	623	8,215	13
Shearmen and helpers	530	6,205	12

[1] Includes barmen, claymen, cinder snappers, keepers, and keepers' helpers.
[2] Includes bottom fillers, cagers, larrymen, scale-car operators, skip-hoist operators, and top fillers.
[3] Includes handy men, machinists and helpers, millwrights, pipe fitters and helpers, and repair men.
[4] Includes catchers, drag downs, finishers, hookers, hook-ups, lever men, manipulators, roll engineers, rollers and helpers, roll hands, roughers, screw men, stranders, and table men.

The number of injuries occurring to each occupation and the total number of days lost by the injured being shown, a simple division discloses the average loss per injury. The highest average, 26 days,

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occurs among oilers and greasers. These workers must necessarily approach the moving parts of the various machines to which they give attention. Until very recently comparatively little attention had been given to rendering their approach safe. They had been allowed to climb into perilous positions and carry on their work under needlessly dangerous conditions. Next in order come crane hookers, with an average of 23 days lost per injury. Men in this occupation are necessarily exposed to very considerable danger. They have to handle constantly masses of moving material of great size and in more or less rapid motion. If a chain slips or a bar falls, the crane hooker is in danger. Following this group are the ladle men in steel works with an average loss per injury of 20 days. While this average is based upon ladle men, it probably applies to other workers in the steel works similarly situated, as for example, the vessel men in the Bessemer works and the pitmen in the open hearth works. The danger in their occupation is closely connected with the handling of hot metal. Explosions of molten metal, the breaking of chains, and other accidents of this character constitute a condition of menace which can be improved only by the most scrupulous care. The switchmen on the railways of the plants also had 20 days of average loss. This showing for the switchmen reenforces what has been said elsewhere with regard to the hazard of their occupation. Special comment is not necessary on the other occupations shown in the table.

COMPARISON OF TIME LOST IN PLANTS HAVING EXTREME CONDITIONS AS TO SAFETY SYSTEMS.

Before passing from the consideration of this matter of lost time per man employed, it is desirable to present another contrast. This is done in the following table:

COMPARISON OF A PLANT WHICH HAS MEASURES FOR SAFETY WITH A PLANT WHICH LACKS SUCH MEASURES, BY DEPARTMENTS.

[Plant A is one in which active measures for safety have been undertaken; Plant X one in which such measures are lacking.]

Departments.	Accident rate per 1,000 300-day workers.[1]		Days lost per injury.		Days lost per 300-day worker.	
	Plant A.	Plant X.	Plant A.	Plant X.	Plant A.	Plant X.
Blast furnace	168	507	15.8	16.1	2.7	8.0
Steel works	291	925	16.0	18.5	4.7	16.9
Rolling mill	202	536	16.2	18.0	3.2	9.7
Yard	147	198	13.4	17.9	2.1	4.2
Mechanical	112	519	13.4	16.9	1.2	9.1
Total	180	508	15.7	17.5	2.8	8.9

[1]All disabling accidents, both fatal and nonfatal.

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Hitherto the facts have been presented mainly by groups of plants, the worse compared with the better. Plant A stands high on the list of those that have undertaken successfully safety activities. Plant X, on the other hand, is among those which may be said to have done almost nothing in this direction.

The table under consideration contrasts extreme conditions. The rate in Plant A is 35 per cent of that in Plant X. The contrast is sufficiently pronounced between the plants taken as a whole. When we direct attention to the different departments a still more striking contrast comes into view. In steel works, for example, Plant X has a rate of 925 against a rate of 291 in Plant A, more than three times as high. In the mechanical department Plant X has a rate nearly five times that of Plant A.

Considering the average loss per injury, an excess in Plant X appears of 4.5 days in the yard department and 3.5 days in the mechanical department. In the plant as a whole the loss is 1.8 days per injury higher. Not only were injuries much more numerous but they were of greater average severity.

This excessive disability from the injuries in Plant X influences the average loss per 300-day worker to such an extent that these losses are in more striking contrast than the rates. In steel works, for example, rates in Plant X were three times those in Plant A. Losses per 300-day worker were nearly four times as great. The facts are shown in the accompanying diagram.

This comparison emphasizes a condition of apathy regarding the occurrence of accidents in such plants as X. The condition is one very largely characteristic of the entire industry not very long ago. Nearly every large plant in the country has at some time been in a situation more or less closely approximating that of Plant X.

Equally, on the other hand, does this table emphasize the possibilities of constructive effort. Plant A started in the effort for safety under circumstances distinctly more discouraging than those which now prevail in Plant X, although its record was never so bad. Plant A presents a high but perfectly attainable standard.

NATURE OF THE INJURY.

RELATION OF INJURY TO PERIOD OF DISABILITY.

Under this heading the relation of the different sorts of injury to the periods of disability will be first considered. Three tables are presented in this connection, the first pertaining to the 130 plants from which data concerning the nature of injury were tabulated for the period of two years ending June 30, 1910; the second relating to a single plant employing an average of 6,624 men for a period of six years ending December 31, 1910; and the third presenting a consolidation of the data contained in the two preceding tables.

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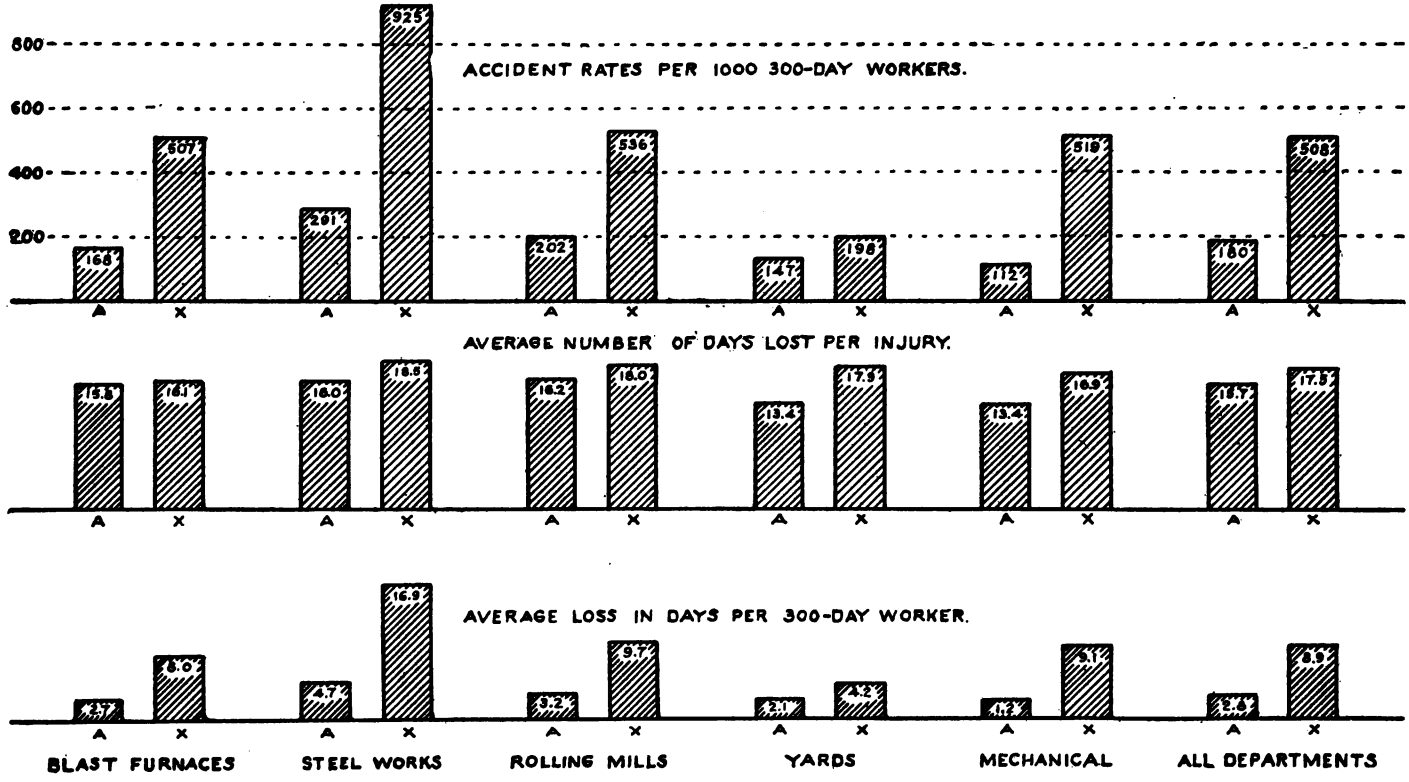
COMPARISON OF PLANT WITH WELL-DEVELOPED SAFETY SYSTEM (A) WITH ONE IN WHICH SUCH SYSTEM IS LACKING (X), BY DEPARTMENTS.



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NATURE OF INJURY AND LENGTH OF ABSENCE FROM WORK

NUMBER OF PERMANENTLY INJURED WHO RETURNED TO WORK IN SPECIFIED WEEK.

Marginal number.	Nature of injuries.	Total.	Per cent of each kind of injury.	First.	Second.	Third.	Fourth.
1	Loss of one arm	10	0.06	.....	.....	.....	.....
2	Loss of one leg	12	.07	.....	.....	.....	.....
3	Loss of one hand	8	.04	.....	.....	.....	.....
4	Loss of both hands	2	.01	.....	.....	.....	.....
5	Loss of thumb	30	.18	.....	4	6	3
6	Loss of first finger	77	.47	7	7	10	10
7	Loss of other fingers	167	1.02	13	17	22	11
8	Loss of one foot	14	.09	.....	.....	.....	.....
9	Loss of one eye	49	.30	1	1	1	4
10	Loss of both eyes	2	.01	.....	.....	.....	.....
11	Total permanent injuries	371	2.25	21	29	39	28

TEMPORARY DISABILITIES (1 DAY OR OVER) TERMINATING IN SPECIFIED WEEK.

1	Eye injuries	1,192	7.26	580	78	26	10
2	Fracture of one arm	70	.43	3	2	4	3
3	Fracture of both arms	1	.....	.....	.....	.....	.....
4	Fracture of one leg	149	.91	1	2	1	2
5	Fracture of both legs	6	.04	.....	.....	.....	.....
6	Fracture of skull	17	.10	1	2	.....	.....
7	Fracture of ribs	110	.69	19	26	14	6
8	Other fractures	75	.46	10	8	4	8
9	Hand crushed or broken	107	.65	19	15	7	7
10	Foot or toes crushed or broken	745	4.53	137	103	47	33
11	Fingers crushed or broken	1,079	6.57	273	154	80	40
12	Hand or fingers bruised, etc	3,369	20.51	1,566	561	209	85
13	Foot or toes bruised, etc	1,928	11.74	877	393	117	66
14	Other parts bruised, etc	3,202	19.49	1,428	470	174	85
15	Dislocations	134	.82	61	27	8	5
16	Punctured wounds	419	2.05	219	46	18	9
17	Asphyxia	33	.20	22	.....	2	.....
18	Burns by hot metal	735	4.07	269	164	71	52
19	Burns by falling stock	9	.05	.....	2	1	3
20	Burns by gas	49	.30	24	11	1	.....
21	Burns by electricity	28	.17	17	2	2	1
22	Burns by steam and water	131	.80	30	32	17	10
23	Burns not specified	1,066	6.49	399	209	76	39
24	Hernia	39	.24	6	2	5	3
25	Plural injuries	272	1.66	71	47	20	13
26	Unclassified	1,061	6.46	509	185	68	26
27	Not reported	31	.19	10	7	7	1
28	Total temporary disabilities	16,057	97.75	6,551	2,568	979	507
29	Per cent terminating in each week	.....	.....	56.2	22.0	8.4	4.4
30	Total nonfatal injuries	16,428	100.0	6,572	2,597	1,018	535

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IN 130 PLANTS, FOR 2 YEARS ENDING JUNE 30, 1910.

NUMBER OF PERMANENTLY INJURED WHO RETURNED TO WORK IN SPECIFIED WEEK.

Fifth.	Sixth.	Seventh.	Eighth.	Ninth.	Tenth.	Eleventh.	Twelfth.	Thirteenth.	Fourteenth and later.	Not reported.	Marginal number.
.....	.....	1	.....	2	.....	.....	1	.....	1	5	1
.....	.....	.....	1	.....	.....	.....	.....	.....	2	9	2
.....	.....	.....	.....	1	.....	.....	.....	.....	2	5	3
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	4
5	2	1	.....	.....	.....	.....	.....	.....	.....	9	5
7	5	.....	1	2	.....	.....	.....	.....	1	27	6
19	9	3	7	4	1	3	1	1	2	54	7
.....	.....	.....	.....	1	.....	.....	.....	2	4	7	8
5	3	1	3	3	.....	.....	.....	2	5	20	9
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	10
36	19	6	12	13	1	3	2	5	17	140	11

TEMPORARY DISABILITIES (1 DAY OR OVER) TERMINATING IN SPECIFIED WEEK.

7	8	5	3	2	1	.....	2	1	2	467	1
7	8	2	4	2	2	3	.....	1	2	27	2
.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	3
6	7	2	6	7	2	1	5	11	18	78	4
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6	5
2	2	1	.....	.....	.....	1	.....	1	1	6	6
7	2	3	1	1	.....	1	.....	.....	.....	30	7
3	3	1	7	3	.....	2	.....	1	2	23	8
6	2	1	2	2	.....	.....	.....	.....	5	41	9
40	24	16	8	15	3	6	1	7	11	294	10
32	20	8	7	3	3	1	.....	.....	3	455	11
49	27	15	7	4	2	4	.....	1	1	818	12
25	18	7	4	12	1	4	.....	2	3	399	13
63	29	12	8	7	7	3	3	5	20	888	14
2	5	3	.....	.....	1	.....	.....	1	.....	21	15
6	3	1	1	.....	.....	.....	.....	.....	1	115	16
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9	17
34	16	6	4	5	1	1	.....	2	10	100	18
.....	1	.....	.....	1	.....	.....	.....	1	.....	.....	19
3	.....	.....	.....	.....	1	.....	.....	1	1	7	20
.....	.....	.....	.....	.....	.....	.....	.....	.....	1	5	21
1	3	1	.....	1	1	.....	.....	1	3	31	22
27	16	9	2	7	6	.....	1	3	10	262	23
1	2	1	1	1	.....	.....	1	.....	3	13	24
8	6	3	2	4	2	.....	.....	2	7	87	25
21	15	6	4	3	2	3	1	.....	6	212	26
.....	.....	.....	1	.....	.....	1	.....	.....	1	3	27
350	217	103	72	81	35	31	14	41	111	4,397	28
3.0	1.9	0.9	0.6	0.7	0.3	0.3	0.1	0.3	1.0	.....	29
386	236	109	84	94	36	34	16	46	128	4,537	30

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NATURE OF INJURY AND LENGTH OF ABSENCE FROM WORK IN A PLANT

NUMBER OF PERMANENTLY INJURED WHO RETURNED TO WORK IN SPECIFIED WEEK.

Marginal number.	Nature of injuries.	Total.	Per cent of each kind of injury.	First.	Second.	Third.	Fourth.
1	Loss of one arm	1	0.01	.....	.....	.....	.....
2	Loss of one leg	7	.09	.....	.....	.....	.....
3	Loss of thumb	7	.09	.....	1	.....	.....
4	Loss of first finger	8	.10	.....	1	1	1
5	Loss of other fingers	31	.41	1	.....	4	3
6	Loss of one foot	3	.04	.....	.....	.....	.....
7	Loss of one eye	9	.12	.....	.....	.....	.....
8	Loss of both eyes	1	.01	.....	.....	.....	.....
9	Total permanent injuries	67	.87	1	2	5	4

TEMPORARY DISABILITIES (1 DAY OR OVER) TERMINATING IN SPECIFIED WEEK.

1	Eye injuries	344	4.51	231	46	17	5
2	Fracture of one arm	56	.73	.....	3	2	2
3	Fracture of both arms	3	.04	.....	.....	.....	.....
4	Fracture of one leg	102	1.34	.....	.....	1	2
5	Fracture of both legs	2	.03	.....	.....	.....	.....
6	Fracture of ribs	22	.29	4	1	.....	1
7	Other fractures	67	.88	2	4	7	5
8	Hand crushed or broken	36	.47	4	2	2	2
9	Foot or toes crushed or broken	178	2.33	3	14	15	21
10	Fingers crushed or broken	356	4.67	51	44	48	56
11	Hand or fingers bruised, etc.	1,346	17.64	666	266	144	81
12	Foot or toes bruised etc.	1,203	15.78	544	249	140	80
13	Other parts bruised, etc.	1,706	22.38	801	338	166	109
14	Dislocations	462	6.06	224	100	39	25
15	Punctured wounds	180	2.36	110	29	16	3
16	Asphyxia	90	1.18	58	12	7	2
17	Burns by hot metal	544	7.18	130	89	70	63
18	Burns by falling stock	80	1.06	15	12	12	12
19	Burns by gas	101	1.32	50	14	13	4
20	Burns by electricity	97	1.27	45	21	18	6
21	Burns by steam and water	98	1.30	24	19	8	13
22	Burns not specified	343	4.56	144	72	41	25
23	Hernia	14	.18	3	.....	1	2
24	Plural injuries	97	1.27	31	11	16	10
25	Unclassified	16	.22	9	1	2	1
26	Not reported	19	.07	5	4	1	1
27	Total temporary disabilities	7,562	99.13	3,154	1,351	786	531
28	Per cent terminating in each week	.....	.....	43.8	18.8	11.0	7.4
29	Total nonfatal injuries	7,629	100.0	3,155	1,353	791	535

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EMPLOYING AN AVERAGE OF 6,624 MEN, 6 YEARS ENDING DEC. 31, 1910.

NUMBER OF PERMANENTLY INJURED WHO RETURNED TO WORK IN SPECIFIED WEEK.

Fifth.	Sixth.	Seventh.	Eighth.	Ninth.	Tenth.	Eleventh.	Twelfth.	Thirteenth.	Fourteenth and later.	Not reported.	Marginal number.
						1					1
									6	1	2
1	1	2		1					1		3
1	1	1								2	4
7	5			2		1	1	1	3	3	5
						1			1	1	6
			1	1		1		2	1	1	7
										1	8
9	7	3	1	4		4	1	3	14	9	9

TEMPORARY DISABILITIES (1 DAY OR OVER) TERMINATING IN SPECIFIED WEEK.

8	1	2	4	4	2	1		3	2	18	1
6	5	2	8	8	4	1		5	9	1	2
							1	1	1		3
2	1	7	3	12	3	4	4	8	49	6	4
					1				1		5
1	5	2	1		1		1		1	4	6
4	6	7	7	3	4	2	1	3	8	4	7
6	4	3	2	3					4	4	8
26	23	12	11	14	9	4	1	4	13	8	9
50	31	14	13	13	3	3	2	2	4	22	10
45	32	13	9	5	2	2	3		8	70	11
50	23	11	11	6	7	2	4	3	7	66	12
98	35	29	12	17	6	3	2	4	18	68	13
25	4	3	5	3	3	2	1	1	5	22	14
1	2	1	1		3	1	1	1	3	8	15
	1		1	3			1			5	16
46	29	15	13	20	9	4	6	3	21	26	17
6	7		3		1	1		2	7	2	18
5	3		2	2	1			2		5	19
1	1	1	1	2						1	20
6	6	4	3	3					7	5	21
17	7	3	5	6	4	1	1		2	15	22
	3			2				1	2		23
11	4	2	3	2		1			3	3	24
1									2		25
	2		1					5			26
415	235	131	119	128	63	32	29	48	177	363	27
5.8	3.3	1.8	1.6	1.8	0.9	0.4	0.4	0.7	2.4		28
424	242	134	120	132	63	36	30	51	191	372	29

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NATURE OF INJURY AND LENGTH OF ABSENCE FROM WORK IN

NUMBER OF PERMANENTLY INJURED WHO RETURNED TO WORK IN SPECIFIED WEEK.

Marginal number.	Nature of injuries.	Total.	Per cent of each kind of injury.	First.	Second.	Third.	Fourth.
1	Loss of one arm	11	0.05	.....	.....	.....	.....
2	Loss of one leg	19	.08	.....	.....	.....	.....
3	Loss of one hand	8	.03	.....	.....	.....	.....
4	Loss of both hands	2	.01	.....	.....	.....	.....
5	Loss of thumb	37	.15	.....	5	6	3
6	Loss of first finger	85	.35	7	8	11	11
7	Loss of other fingers	198	.82	14	17	26	14
8	Loss of one foot	17	.07	.....	.....	.....	.....
9	Loss of one eye	58	.24	1	1	1	4
10	Loss of both eyes	3	.01	.....	.....	.....	.....
11	Total permanent injuries	438	1.82	22	31	44	32

TEMPORARY DISABILITIES (1 DAY OR OVER) TERMINATING IN SPECIFIED WEEK.

1	Eye injuries	1,536	6.38	811	124	43	15
2	Fracture of one arm	126	.52	3	5	6	5
3	Fracture of both arms	4	.02	.....	.....	.....	.....
4	Fracture of one leg	251	1.04	1	2	2	4
5	Fracture of both legs	8	.03	.....	.....	.....	.....
6	Fracture of skull	17	.07	1	2	.....	.....
7	Fracture of ribs	132	.55	23	27	14	7
8	Other fractures	142	.57	12	12	11	13
9	Hand crushed or broken	143	.59	23	17	9	9
10	Foot or toes crushed or broken	923	3.84	140	117	62	54
11	Fingers crushed or broken	1,435	6.00	324	198	128	96
12	Hand or fingers bruised, etc	4,715	19.60	2,232	847	353	166
13	Foot or toes bruised, etc	3,131	13.02	1,421	642	257	146
14	Other parts bruised, etc	4,908	20.40	2,229	808	340	194
15	Dislocations	596	2.48	285	127	47	30
16	Punctured wounds	599	2.49	329	75	34	12
17	Asphyxia	123	.51	80	12	9	2
18	Burns by hot metal	1,279	5.33	399	253	141	115
19	Burns by falling stock	89	.37	15	14	13	15
20	Burns by gas	150	.62	74	25	14	4
21	Burns by electricity	125	.52	62	23	20	7
22	Burns by steam and water	229	.95	54	51	25	23
23	Burns not specified	1,409	5.86	543	281	117	64
24	Hernia	53	.22	9	2	6	5
25	Plural injuries	369	1.53	102	58	36	23
26	Unclassified	1,077	4.48	518	186	70	27
27	Not reported	50	.21	15	11	8	2
28	Total temporary disabilities	23,619	98.18	9,705	3,919	1,765	1,038
29	Per cent terminating in each week	.....	.....	51.4	20.8	9.4	5.5
30	Total nonfatal injuries	24,057	100.0	9,727	3,950	1,809	1,070

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130 PLANTS FOR 2 YEARS AND 1 PLANT FOR 6 YEARS, COMBINED.

NUMBER OF PERMANENTLY INJURED WHO RETURNED TO WORK IN SPECIFIED WEEK.

Fifth.	Sixth.	Seventh.	Eighth.	Ninth.	Tenth.	Eleventh.	Twelfth.	Thirteenth.	Fourteenth and later.	Not reported.	Marginal number.
.....	.....	1	.....	2	.....	1	1	.....	1	5	1
.....	.....	.....	1	.....	.....	.....	.....	.....	8	10	2
.....	.....	.....	.....	1	.....	.....	.....	.....	2	5	3
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	4
6	3	3	.....	1	.....	.....	.....	.....	1	9	5
8	6	1	1	2	.....	.....	.....	.....	1	29	6
26	14	3	7	6	1	4	2	2	5	57	7
.....	.....	.....	.....	1	.....	1	.....	2	5	8	8
5	3	1	4	4	.....	1	.....	4	8	21	9
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	10
45	26	9	13	17	1	7	3	8	31	149	11

TEMPORARY DISABILITIES (1 DAY OR OVER) TERMINATING IN SPECIFIED WEEK.

15	9	7	7	6	3	1	2	4	4	485	1
13	13	4	12	10	6	4	.....	6	11	28	2
.....	.....	.....	.....	1	.....	.....	1	1	1	.....	3
8	8	9	9	19	5	5	9	19	67	84	4
.....	.....	.....	.....	.....	1	.....	.....	.....	1	6	5
2	2	1	.....	.....	.....	1	.....	1	1	6	6
8	7	5	2	1	1	1	1	.....	1	34	7
7	9	8	14	6	4	4	1	4	10	27	8
12	6	4	4	5	.....	.....	.....	.....	9	45	9
66	47	28	19	29	12	10	2	11	24	302	10
82	51	22	20	16	6	4	2	2	7	477	11
94	59	28	16	9	4	6	3	1	9	888	12
75	41	18	15	18	8	6	4	5	10	465	13
161	64	41	20	24	13	6	5	9	38	956	14
27	9	6	5	3	4	2	1	2	5	43	15
7	5	2	2	.....	3	1	1	1	4	123	16
.....	1	.....	1	3	.....	.....	1	.....	.....	14	17
80	45	21	17	25	10	5	6	5	31	126	18
6	8	.....	3	1	1	1	.....	3	7	2	19
8	3	.....	2	2	2	.....	.....	3	1	12	20
1	1	1	1	2	.....	.....	.....	.....	1	6	21
7	9	5	3	4	1	.....	.....	1	10	36	22
44	23	12	7	13	10	1	2	3	12	277	23
1	5	1	1	3	.....	.....	1	1	5	13	24
19	10	5	5	6	2	1	.....	2	10	90	25
22	15	6	4	3	2	3	1	.....	6	212	26
.....	2	.....	2	.....	.....	1	.....	5	1	3	27
765	452	234	191	209	98	63	43	89	288	4,760	28
4.1	2.4	1.3	1.0	1.1	0.5	0.3	0.2	0.5	1.5	.....	29
810	478	243	204	226	99	70	46	97	319	4,909	30

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Regarding the first two tables it will be noted that there is marked disagreement in the proportion of eye injuries. Reference to the table on page 70, where injuries are arranged by departments, will show that foundries have a great number of injuries to the eye. The preponderance of eye injuries in the table for 130 plants is due to the number of foundries included. The single plant under consideration has a foundry, but the character of the work conducted therein is not such as to give rise to the proportion of eye injuries occurring in foundries in general.

The consolidated table shows that the accidents known to entail some permanent injury are 1.8 per cent of all the cases. It is probable that this percentage does not include all the injuries which entail some permanent disability. Among those classified as temporary disabilities, whose duration is determined by the return of the injured workman to his employment, there are doubtless quite a number of cases in which the man returns but is not able to resume his former occupation or earn the same wages that he earned before being injured. It was not possible in this compilation to isolate such cases as these. There may be among those whose length of disability is not reported other cases of a similar kind in which, as the man does not return to his former employment, his ultimate condition is unknown. These statements need to be made in view of the fact that the class of "permanent injuries" might be regarded as comparable with the group of "permanent disabilities" shown in foreign reports. The two groups are not strictly comparable. There are cases included among the permanent injuries which would not be included among permanent disabilities. The reverse condition is also true. It is quite impossible, therefore, to say whether the groups would be equalized if they could be reduced to the same basis, or which would be the larger.

A few further details may be noted with regard to some of the injuries specified in the table. Inspection will show that injuries to the hands and feet and general bruises and lacerations of other parts of the body constitute very much the larger part of all the injuries. The percentages are: Hand, 26.2 per cent; foot, 16.9 per cent; bruises, etc., to other parts of the body, 20.4 per cent; burns more or less severe come next in order with 13.7 per cent, while eye injuries are 6.4 per cent.

RELATION OF INJURY TO LOSS OF TIME.

The relative severity of injuries is best illustrated by the consideration of the time lost as a result of them. For example, injuries to the foot are found to entail an average loss of 16 days; those to the hand an average loss of 13 days. The highest average loss

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shown by any of the injuries is due to fracture. They constitute 2.6 per cent of all injuries with an average loss of 29 days. Burns constitute 15 per cent, their average loss being 19 days. Asphyxia, though of considerable importance in fatal cases, is naturally less so in these nonfatal injuries. Six-tenths per cent of all injuries are due to this cause and involve an average loss of 2 days.

A view of the relation of the different injuries may be obtained from the table which follows. This table brings together all the injuries for which time lost was reported and relates to 130 plants for 2 years and 1 plant for 6 years:

AVERAGE DAYS LOST FOR SPECIFIED KINDS OF INJURY IN ALL PLANTS REPORTING TIME LOST.

[Figures cover 130 plants for 2 years ending June 30, 1910, and 1 plant for 6 years ending Dec. 31, 1910.]

Kind of injury.	Injuries.		Days lost.		Average days lost per injury.
	Number.[1]	Per cent of each kind.[2]	Number.[3]	Per cent from injuries of each kind.[4]	
Eye injuries	1,056	5.6	9,640	3.3	6
Fractures	497	2.6	27,461	9.4	29
Injuries to hand	4,908	25.9	65,146	22.3	13
Injuries to foot	3,306	17.4	52,584	18.0	16
Injuries to other parts	3,969	20.9	51,124	17.5	13
Dislocations	555	2.9	7,888	2.7	14
Burns	2,842	15.0	53,169	18.2	19
Asphyxia	710	.6	1,169	.4	2
Other injuries	1,716	9.0	23,955	8.2	14
Total	18,959	100.0	292,136	100.0	16

[1] The total in this column covers all injuries for which actual days lost were reported. The number of injuries of each kind are calculated on the basis of the per cents shown in the next column.

[2] These per cents are based on data shown in the table on pp. 66 and 67. They represent only those temporary injuries for which length of absence from work was reported and therefore are not the same as the per cents shown in the table.

[3] The total in this column covers the actual days lost on account of all injuries for which days lost were reported. (See pp. 53 and 124.) The number due to injuries of each kind are calculated on the basis of the per cents shown in the next to last column.

[4] These per cents are based on a computation of days lost from injuries of each kind, made by applying the average days lost from injuries terminating in each week to the number of injuries terminating in the respective weeks, as shown in the table on pp. 66 and 67. The average days lost from injuries terminating in each week were as follows: First week, 4 days; second, 11 days; third, 18 days; fourth, 25 days; fifth, 32 days; sixth, 39 days; seventh, 46 days; eighth, 53 days; ninth, 60 days; tenth, 67 days; eleventh, 74 days; twelfth, 81 days; thirteenth, 88 days; fourteenth and later, 167 days.

The average loss per injury will be seen to vary from 2 days for the cases of asphyxia to 29 days for the cases of fracture, the average for all cases being 16. Burns with 15 per cent of the cases and 18 per cent of the loss are noteworthy. Asphyxia, to whose importance as a cause of death and as a probable element in the occurrence of other accidents attention has been directed, has a very small percentage of cases (0.6) and a still smaller percentage of lost time (0.4).

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RELATION OF INJURY TO DEPARTMENTS.

The following table shows the nature of the injuries in the various departments. The figures represent in combination the data for 130 plants for 2 years ending June 30, 1910, and those for 1 large plant for the 6 years ending December 31, 1910.

NATURE OF INJURY, BY DEPARTMENTS, IN 130 PLANTS FOR 2 YEARS ENDING JUNE 30, 1910, AND 1 PLANT FOR 6 YEARS ENDING DEC. 31, 1910.

NUMBER OF INJURIES.

Nature of injuries.	Blast furnaces.	Steel works.	Rolling mills.	Foundries.	Mechanical.	Yards.	Miscellaneous.	Not reported.	Total.
PERMANENT INJURIES.									
Loss of one arm	.....	1	3	2	4	1	.....	.....	11
Loss of one leg	3	2	1	3	3	7	.....	.....	19
Loss of one hand	1	.....	.....	2	.....	.....	3	2	8
Loss of both hands	.....	.....	.....	1	.....	.....	1	.....	2
Loss of thumb	2	3	8	3	2	5	12	2	37
Loss of first finger	5	3	21	13	13	7	16	7	85
Loss of other fingers	17	13	49	27	31	20	26	15	198
Loss of one foot	2	3	4	.....	2	3	3	.....	17
Loss of one eye	4	6	8	10	10	6	10	4	58
Loss of both eyes	1	2	.....	.....	.....	.....	.....	.....	3
Total permanent injuries	35	33	94	61	65	49	71	30	438
TEMPORARY DISABILITIES.									
Eye injuries	162	101	177	529	276	90	157	44	1,536
Fracture of one arm	19	16	26	12	16	14	18	5	126
Fracture of both arms	1	.....	.....	.....	1	.....	2	.....	4
Fracture of one leg	32	28	54	37	33	37	24	6	251
Fracture of both legs	.....	.....	.....	4	1	.....	3	.....	8
Fracture of skull	4	3	1	3	1	1	4	.....	17
Fracture of ribs	24	14	19	3	21	17	25	9	132
Fractures not specified	18	24	35	12	21	13	14	5	142
Hand crushed or broken	16	18	24	27	16	20	16	6	143
Foot or toes crushed or broken	102	91	196	150	71	127	88	98	923
Fingers crushed or broken	128	121	275	363	156	173	127	92	1,435
Hand or fingers bruised, etc	496	382	1,198	638	584	578	499	340	4,715
Foot or toes bruised, etc	448	290	804	386	305	505	216	177	3,131
Other bruises, cuts, etc	760	508	1,099	516	550	646	543	286	4,908
Dislocations	90	96	113	45	112	94	46	.....	596
Punctured wounds	68	36	140	67	110	61	86	31	599
Asphyxia	77	9	4	1	11	4	17	.....	123
Burns by hot metal	320	427	250	186	24	14	47	11	1,279
Burns by gas	49	43	16	7	13	.....	21	1	150
Burns by electricity	15	9	38	4	10	3	46	.....	125
Burns by steam and water	76	19	21	7	29	23	49	5	229
Burns not specified [1]	433	166	400	92	82	60	150	115	1,498
Hernia	5	4	12	7	12	4	6	3	53
Plural injuries	55	39	75	44	50	48	37	21	369
Unclassified	129	93	257	67	118	116	143	154	1,077
Not reported	2	7	6	5	.....	5	15	10	50
Total temporary disabilities	3,529	2,544	5,240	3,212	2,623	2,653	2,399	1,419	23,619
Total nonfatal injuries	3,564	2,577	5,334	3,273	2,688	2,702	2,470	1,449	24,057

[1] Including burns from falling stock.

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NATURE OF INJURY, BY DEPARTMENTS, IN 130 PLANTS FOR 2 YEARS ENDING JUNE 30, 1910, AND 1 PLANT FOR 6 YEARS ENDING DEC. 31, 1910—Concluded.

PER CENT OF INJURIES OF EACH NATURE.

Nature of injuries.	Blast furnaces.	Steel works.	Rolling mills.	Foundries.	Mechanical.	Yards.	Miscellaneous.	Not reported.	Total.
Total permanent injuries	1.0	1.3	1.8	1.8	2.4	1.8	2.9	2.1	1.8
TEMPORARY DISABILITIES.									
Eye injuries	4.5	3.9	3.3	16.2	10.3	3.3	6.4	3.0	6.4
Fracture of one arm	.5	.6	.5	.4	.6	.5	.7	.3	.5
Fracture of both arms	(1)				(1)			.1	(1)
Fracture of one leg	.9	1.1	1.0	1.5	1.2	1.4	1.0	.4	1.0
Fracture of both legs				.1	(1)		.1		(1)
Fracture of skull	.1	.1	(1)	.1	(1)	(1)	.2		.1
Fracture of ribs	.7	.5	.4	.1	.3	.6	1.0	.6	.5
Other fractures	.5	.9	.7	.4	.3	.5	.6	.3	.6
Hand crushed or broken	.4	.7	.4	.3	.6	.7	.6	.4	.6
Foot or toes crushed or broken	2.9	3.5	3.7	4.6	2.6	4.7	3.6	6.8	3.8
Fingers crushed or broken	3.6	4.7	5.2	11.1	5.3	6.4	5.1	6.3	6.0
Hand or fingers bruised, etc	13.9	14.7	22.5	19.5	21.7	21.4	20.2	23.5	19.6
Foot or toes bruised, etc	12.6	11.3	15.1	11.8	11.3	18.7	8.7	12.2	13.0
Other bruises, cuts, etc	21.3	19.7	20.6	15.8	20.5	23.9	22.0	19.7	20.4
Dislocations	2.5	3.7	2.1	1.3	4.2	3.5	1.9		2.5
Punctured wounds	1.9	1.4	2.6	2.0	4.1	2.3	3.5	2.1	2.5
Asphyxia	2.2	.3	.1	(1)	.4	.1	.7		.5
Burns by hot metal	9.0	16.6	4.7	5.7	.9	.5	1.9	.8	5.3
Burns by gas	1.4	1.7	.3	.2	.5		.9	(1)	.6
Burns by electricity	.4	.3	.7	.1	.4	.1	1.9		.5
Burns by steam and water	2.1	.7	.4	.2	1.1	.9	2.0	.3	1.0
Burns not specified[2]	12.1	6.4	7.5	2.8	3.1	2.2	6.1	7.9	6.2
Hernia	.1	.2	.2	.2	.4	.1	.2	.2	.2
Plural injuries	1.5	1.5	1.4	1.2	1.9	1.8	1.5	1.4	1.5
Unclassified	3.6	3.6	4.8	2.0	4.4	4.3	5.8	10.6	4.5
Not reported	.1	.3	.1	.2		.2	.6	.7	.2
Total temporary disabilities	98.9	98.7	98.2	98.1	97.7	98.2	97.1	97.9	98.2

[1] Less than one-tenth of 1 per cent.

[2] Including burns from falling stock.

This table calls for comparatively little comment. The percentage portion of the table shows in bold-faced type the points where in number the injuries are concentrated. For example, bruises to hands, feet, and other parts of the body constitute a large percentage of the injuries, and this is especially marked in rolling mills and yards. It has already been seen that eye injuries comprise a considerable number, and it here appears that the percentage (16.2) in foundries is mainly responsible for the prominence of injuries of this nature. The reason for this is that in foundries there is a great deal of the operation known as chipping. Roughnesses and imperfections are removed from the surfaces of the castings by means of chisels, either hand operated or actuated by compressed air. The chips fly frequently and violently from this operation. Their force is not, as a rule, sufficient to cause injury when striking the general surface of the body, but when the chips of steel strike the eye they may cause all degrees of injury from simple irritation to loss of the eye. The steel works show the highest proportion of burns from hot metal, while for all burns the blast furnaces stand at the top.

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DISTRIBUTION OF ACCIDENTS THROUGH THE MONTHS OF THE YEAR.

The interest of presenting the distribution of accidents through the months of the year lies in its bearing upon the question of the effect of the extreme of summer heat upon the accident results in an industry, one of whose constant accompaniments in many occupations is an excessively high temperature. It is not thought that the details of the tabulation will be of interest, and accordingly the material from different sources is consolidated into the briefest possible compass. The returns here presented are for one large plant for a period six years. The total number of accident cases is 7,750.

DISTRIBUTION OF ACCIDENTS IN MONTHS OF THE YEAR, FOR 1 PLANT DURING 6 YEARS ENDING DECEMBER 31, 1910.

Months.	Number of 300-day workers.	Number of injuries.	Monthly accident rate per 1,000 300-day workers.
January	38,026	663	17.4
February	39,276	668	17.0
March	40,008	641	16.0
April	39,347	620	15.8
May	40,651	618	12.7
June	40,516	634	15.9
July	39,380	644	16.4
August	39,659	743	18.7
September	39,963	640	16.0
October	39,697	695	17.5
November	39,805	577	14.5
December	38,162	607	15.9

The discussion of the distribution of accidents through the months is of very little significance unless we are informed with regard to the number of people employed. The iron and steel industry fluctuates very materially from month to month, and so the number of accidents occurring in a given month may not be at all an index of the real conditions. It is possible in this case not only to aggregate the accidents occurring in each month of these 6 years, but also to determine the number of 300-day workers employed. It is possible, therefore, to compute rates for these months which probably possess some definite significance. The facts are graphically shown in the accompanying diagram.

There is, as will be observed, a steady decline in the accident rate from January to May. A rise then begins which culminates in August. From this point there is an irregular change to November, then a rather abrupt rise to the peak in January. It seems a reasonable conclusion to draw from these figures that both the extremes of heat and of cold have an influence in the occurrence of steel plant accidents, the heat condition being the more potent. The month of October appears as something of an anomaly when considered simply in this relation of the effects of heat and cold. It has a rate

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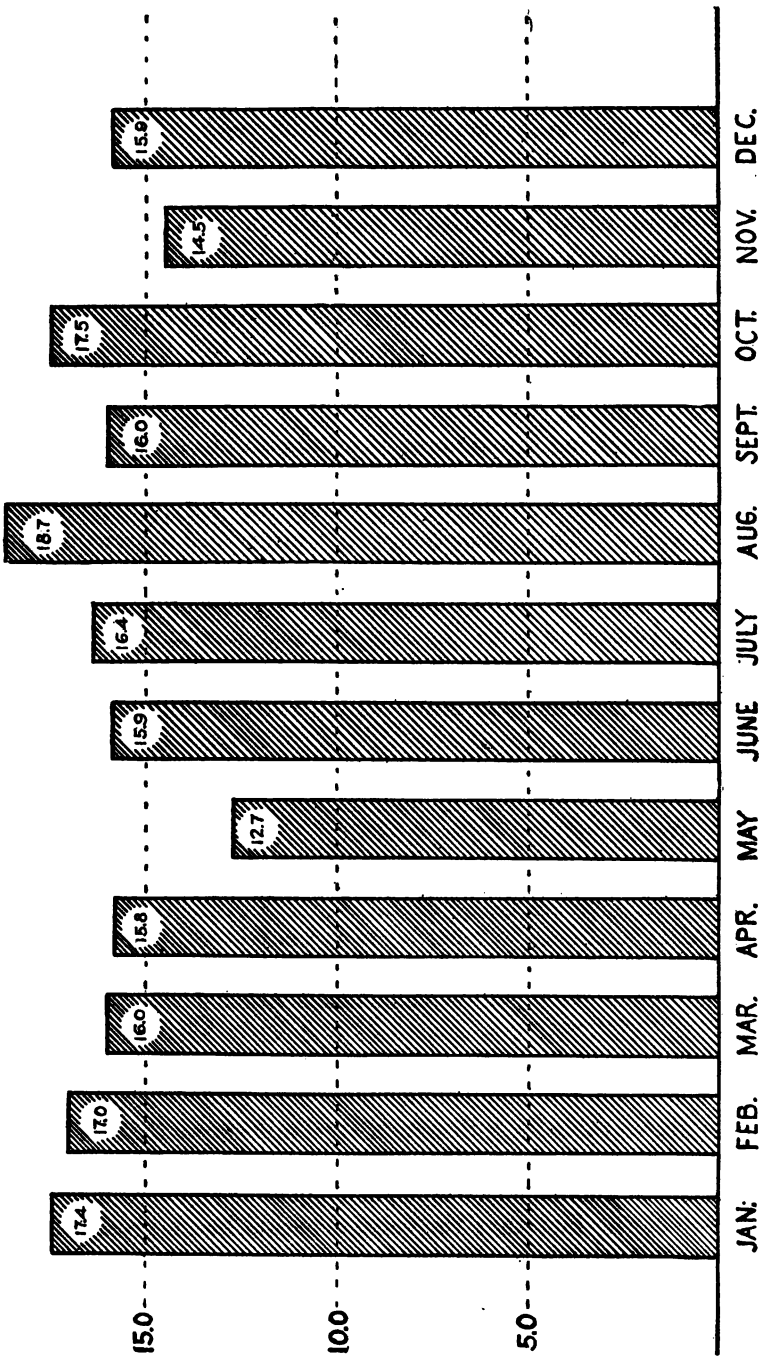
AVERAGE MONTHLY ACCIDENT RATE PER 1,000 300-DAY WORKERS IN A LARGE PLANT, 1905 TO 1910.



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slightly higher than that of January. The explanation of this condition is probably to be found in the fact that in this particular plant the month of October has been most frequently chosen as what is called a "record month." In the rivalry between different steel mills in the matter of output it has been often the custom to attempt a record output in certain months of the year. The climatic conditions are on the whole more favorable in the months of October and of March, and these have been more frequently chosen than any other. The relation which has already been shown to exist between degrees of activity and accident rates would lead us to expect that while a given record month might show no higher rate than ordinary months, the aggregate of a series of such months would show a higher level. In this table the figures for October seem to indicate the tendency of such months to produce a higher accident rate than prevails in ordinary months.

A table showing the amount of production in a Bessemer steel mill in two winter and two summer months is here introduced as throwing some additional light upon the effect of high temperature upon accident rate. There is evidence that intensified activity is normally correlated with an increased accident rate,[1] and the table just under consideration leads to the conclusion that the high temperatures of summer, combined with the temperature conditions of the steel industry, also tend to increase the rate.

PRODUCTION OF A BESSEMER STEEL MILL IN TWO COLD AND TWO WARM MONTHS OF THE YEAR.

Months.	Number of blows.						
	Vessel A.			Vessel B.			Grand total.
	Day.	Night.	Total.	Day.	Night.	Total.	
January	1,134	1,226	2,360	1,138	1,232	2,370	4,730
February	925	886	1,811	937	929	1,866	3,677
Total	2,059	2,112	4,171	2,075	2,161	4,236	8,407
July	674	678	1,352	670	668	1,338	2,690
August	862	812	1,674	838	818	1,656	3,330
Total	1,536	1,490	3,026	1,508	1,486	2,994	6,020

The above table for a Bessemer steel mill shows that for the months of January and February in a given year there were 8,407 "blows" in vessels A and B. In July and August there were 6,020 "blows." In view of the fact that the second period has a greater number of days, this contrast is slightly less pronounced than it would be if the periods were of the same length. The details of this table show an excess of activity in the cooler months in each case. The "blows" of day and night turns were more numerous at cooler

[1] See discussion on pp. 120 and 121.

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periods, and so with each element going to make up the total. It is believed that a similar study of the output of other mills would show that a greater amount of work is accomplished in the cooler months.

This relation is of importance. In spite of lessened activity, which would be expected to bring a decrease in accidents, the summer shows a slightly higher rate than the more active winter. Direct study of the extreme conditions [1] resulting from summer heat and steel-work temperatures seems to indicate that the accident rate at that season is, in part at least, the result of those conditions.

The steel mills recognize the difficulties of the summer season by increasing the number of "spell hands" and by other efforts to alleviate a trying situation. Probably nothing will do more for the comfort of the men, and incidentally for their safety, than well-considered efforts at ventilation. A possible result of such efforts is illustrated by a fact learned in connection with another investigation. In a plant devoted to the production of malleable castings there were during the summer frequent cases of heat prostration in the annealing room and serious discomfort for all workmen there engaged. Finally a system of swinging fans was installed which kept the air in motion throughout the room. The cases of prostration ceased, and the men instead of coming from the room entirely exhausted at the end of their day were no more weary than workers from other rooms. The physical condition of these men before the fans were in use would necessarily conduce to accident. The use of ventilating fans may therefore be considered not only a needed contribution to the comfort of hard-pressed workmen but a distinct safety device.

DISTRIBUTION OF ACCIDENTS THROUGH THE HOURS OF THE DAY.

There has been in the minds of those who have discussed the question of accident distribution a very strong impression that accidents increase regularly throughout the working period in some direct relation to the increasing fatigue of the workers. In an earlier publication of the Bureau [2] this subject received attention, and data covering a larger number of cases than had hitherto been assembled are there presented. For several reasons the iron and steel industry presents a satisfactory opportunity for the investigation of this subject. Owing to the established custom of continuous operation throughout the 24 hours of the working-day, this industry has in the two periods a more uniform working force than almost any other industry. The night period is almost entirely given over to the characteristic steel workers. They begin their work at 6 o'clock and continue practically without interruption to 6 o'clock the following morning. By the use of reliefs and spell hands and mechanical methods the mills are, when

[1] Working Conditions and the Relation of Employers and Employees, Vol. III of this report, p. 287 et seq.

[2] Report on Condition of Woman and Child Wage-Earners in the United States, Vol. XI: Employment of Women in Metal Trades, pp. 94 to 98.

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running satisfactorily, kept in constant activity. The midnight meal does not mark a period when the machinery regularly shuts down, but the men spell each other in such a way that each man has opportunity for eating; but the work goes on continuously. During the day turn there is a similar body of workers, supplemented by a large force of 10-hour men. These 10-hour men come on duty at 7 o'clock and conclude their work normally at 5 o'clock. This gives in the 24 hours two periods of very nearly uniform employment. Certain special modifications of this uniformity will be pointed out at the proper place. The information presented with regard to this subject covers four groups of accidents, as follows: A group of 7,750 occurring in 1 large plant during a period of 6 years, a group of 3,988 occurring in 161 small plants during 2 years, 16,988 in a group of larger plants for 2 years, and 1 large company operating 4 plants for a period of 2 years with 3,261 accidents. The total number of accidents for which the hour of occurrence was reported is 26,839. The statistics are presented in the four tables which follow. The first table presents the material for the period of six years in one large plant by years. The second presents the same data by departments. The third table arranges the data from large plants for two years by departments. The fourth table consolidates the data for each of these groups and presents also the data for 161 small plants and 1 large company with 4 establishments, together with a final total.

DISTRIBUTION THROUGH THE DAY OF INJURIES IN 1 PLANT FOR 6 YEARS ENDING DECEMBER 31, 1910, BY YEARS.

Hours.	Number of injuries.						
	1905	1906	1907	1908	1909	1910	Total.
DAY TURN.							
6.01 to 7 a. m.	39	44	32	18	28	28	189
7.01 to 8 a. m.	70	73	96	44	58	65	406
8.01 to 9 a. m.	100	87	76	44	57	66	430
9.01 to 10 a. m.	123	94	90	49	63	70	489
10.01 to 11 a. m.	100	93	93	47	54	69	456
11.01 to 12 a. m.	68	59	44	32	49	42	294
Total forenoon	500	450	431	234	309	340	2,264
12.01 to 1 p. m.	65	50	40	19	37	28	239
1.01 to 2 p. m.	106	109	90	60	73	70	508
2.01 to 3 p. m.	126	95	80	68	79	75	523
3.01 to 4 p. m.	120	87	85	55	65	60	472
4.01 to 5 p. m.	84	76	68	29	75	53	385
5.01 to 6 p. m.	52	53	40	19	33	22	219
Total afternoon	553	470	403	250	362	308	2,346
Total day turn	1,053	920	834	484	671	648	4,610
NIGHT TURN.							
6.01 to 7 p. m.	49	43	47	23	40	26	228
7.01 to 8 p. m.	47	49	52	17	32	38	235
8.01 to 9 p. m.	44	70	49	14	35	30	242
9.01 to 10 p. m.	66	69	38	14	33	36	256
10.01 to 11 p. m.	51	31	47	17	43	28	217
11.01 to 12 p. m.	48	41	28	13	28	30	188
Total first half of night	305	303	261	98	211	188	1,366

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DISTRIBUTION THROUGH THE DAY OF INJURIES IN 1 PLANT FOR 6 YEARS ENDING DECEMBER 31, 1910, BY YEARS—Concluded.

Hours.	Number of injuries.						
	1905	1906	1907	1908	1909	1910	Total.
NIGHT TURN—concluded.							
12.01 to 1 a. m.	38	26	35	4	21	15	139
1.01 to 2 a. m.	55	40	35	20	34	28	212
2.01 to 3 a. m.	67	48	58	19	38	39	269
3.01 to 4 a. m.	60	49	35	10	19	21	194
4.01 to 5 a. m.	41	42	37	11	25	23	179
5.01 to 6 a. m.	36	35	46	7	25	18	167
Total second half of night	297	240	246	71	162	144	1,160
Total night turn	602	543	507	109	373	332	2,526
Total reported	1,655	1,463	1,341	653	1,044	980	7,136
Not reported	266	143	93	32	40	40	614
Grand total	1,921	1,606	1,434	685	1,084	1,020	7,750

DISTRIBUTION THROUGH THE DAY OF INJURIES IN 1 PLANT FOR 6 YEARS ENDING DECEMBER 31, 1910, BY DEPARTMENTS.

Hours.	Number of injuries.							
	Blast furnaces.	Bessemer.	Open hearth.	Rolling mills.	Mechanical.	Yards.	Miscellaneous departments.	Total.
DAY TURN.								
6.01 to 7 a. m.	41	22	26	50	14	22	14	189
7.01 to 8 a. m.	105	27	39	80	67	48	40	406
8.01 to 9 a. m.	100	18	44	98	78	49	43	430
9.01 to 10 a. m.	114	26	47	104	93	59	46	489
10.01 to 11 a. m.	91	34	50	103	73	59	46	456
11.01 to 12 a. m.	52	24	28	90	41	33	26	294
Total forenoon	503	151	234	525	366	270	215	2,264
12.01 to 1 p. m.	56	15	30	45	39	29	25	239
1.01 to 2 p. m.	114	31	52	118	97	61	35	508
2.01 to 3 p. m.	113	27	53	103	92	64	71	523
3.01 to 4 p. m.	107	26	45	111	81	58	44	472
4.01 to 5 p. m.	80	26	37	79	73	36	54	385
5.01 to 6 p. m.	52	23	21	53	26	27	17	219
Total afternoon	522	148	238	509	408	275	246	2,346
Total day turn	1,025	299	472	1,034	774	545	461	4,610
NIGHT TURN.								
6.01 to 7 p. m.	49	18	31	70	23	13	24	228
7.01 to 8 p. m.	41	18	39	71	16	31	19	235
8.01 to 9 p. m.	56	26	24	63	23	26	24	242
9.01 to 10 p. m.	67	22	23	72	25	26	21	256
10.01 to 11 p. m.	48	12	33	77	11	22	14	217
11.01 to 12 p. m.	39	15	23	50	14	30	17	188
Total first half of night	300	111	173	403	112	148	119	1,366
12.01 to 1 a. m.	29	16	22	40	10	13	9	139
1.01 to 2 a. m.	38	18	34	74	12	24	12	212
2.01 to 3 a. m.	69	16	45	72	21	33	13	269
3.01 to 4 a. m.	44	22	24	52	10	25	17	194
4.01 to 5 a. m.	38	19	26	54	13	14	15	179
5.01 to 6 a. m.	45	21	23	48	10	15	5	167
Total second half of night	263	112	174	340	76	124	71	1,160
Total night turn	563	223	347	743	188	272	190	2,526
Total reported	1,588	522	819	1,777	962	817	651	7,136
Not reported	161	48	65	121	86	87	46	614
Grand total	1,749	570	884	1,898	1,048	904	697	7,750

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DISTRIBUTION THROUGH THE DAY OF INJURIES IN 122 PLANTS FOR 2 YEARS ENDING JUNE 30, 1910, BY DEPARTMENTS.

Hours.	Number of injuries.						
	Blast furnaces.	Steel works.	Rolling mills.	Mechanical occupations.	Yards.	Miscellaneous departments.	Total.
DAY TURN.							
6.01 to 7 a. m.	59	42	97	22	39	110	369
7.01 to 8 a. m.	104	50	173	93	117	309	846
8.01 to 9 a. m.	138	76	219	146	160	372	1,111
9.01 to 10 a. m.	121	79	249	152	172	436	1,209
10.01 to 11 a. m.	119	83	209	163	129	406	1,109
11.01 to 12 a. m.	79	58	119	89	83	222	650
Total forenoon	620	388	1,066	665	700	1,855	5,294
12.01 to 1 p. m.	73	30	117	66	53	185	524
1.01 to 2 p. m.	110	59	209	124	123	334	959
2.01 to 3 p. m.	113	67	217	151	137	391	1,076
3.01 to 4 p. m.	132	70	193	116	140	349	1,000
4.01 to 5 p. m.	91	53	156	102	97	281	780
5.01 to 6 p. m.	37	36	122	48	50	139	432
Total afternoon	556	315	1,014	607	600	1,679	4,771
Total day turn	1,176	703	2,080	1,272	1,300	3,534	10,065
NIGHT TURN.							
6.01 to 7 p. m.	43	37	117	24	36	98	355
7.01 to 8 p. m.	46	42	117	30	51	130	416
8.01 to 9 p. m.	48	55	115	24	43	123	408
9.01 to 10 p. m.	54	38	93	29	44	103	361
10.01 to 11 p. m.	45	34	114	20	43	119	375
11.01 to 12 p. m.	40	26	78	13	19	64	240
Total first half of night	276	232	634	140	236	637	2,155
12.01 to 1 a. m.	36	31	57	16	12	57	209
1.01 to 2 a. m.	23	45	81	14	35	96	294
2.01 to 3 a. m.	43	23	74	12	30	94	276
3.01 to 4 a. m.	41	27	52	13	24	94	251
4.01 to 5 a. m.	41	21	62	15	35	80	254
5.01 to 6 a. m.	42	32	85	7	26	70	262
Total second half of night	226	179	411	77	162	491	1,546
Total night turn	502	411	1,045	217	398	1,128	3,701
Total reported	1,678	1,114	3,125	1,489	1,698	4,662	13,766
Not reported	143	747	572	588	320	852	3,222
Grand total	1,821	1,861	3,697	2,077	2,018	5,514	16,988

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DISTRIBUTION THROUGH THE DAY OF INJURIES IN ALL PLANTS FOR WHICH INFORMATION WAS AVAILABLE.

Hours.	Number of injuries.					Per cent at each hour based on—	
	161 small plants,[1] 2 years.	122 large plants, 2 years.	Large company, 4 plants, 2 years.	Large plant, 6 years.	Total.	6-hour periods.	12-hour periods.
DAY TURN.							
6.01 to 7 a. m.	75	369	79	189	712	7.28	3.77
7.01 to 8 a. m.	190	846	145	406	1,587	16.22	8.40
8.01 to 9 a. m.	252	1,111	201	430	1,994	20.38	10.55
9.01 to 10 a. m.	300	1,209	244	489	2,242	22.92	11.86
10.01 to 11 a. m.	223	1,109	193	456	1,981	20.25	10.48
11.01 a. m. to 12 m.	154	650	170	294	1,268	12.96	6.71
Total forenoon	1,194	5,294	1,032	2,264	9,784	100.00	51.76
12.01 to 1 p. m.	123	524	117	239	1,003	11.00	5.31
1.01 to 2 p. m.	221	959	187	508	1,875	20.56	9.92
2.01 to 3 p. m.	223	1,076	220	523	2,042	22.39	10.80
3.01 to 4 p. m.	240	1,000	188	472	1,900	20.83	10.05
4.01 to 5 p. m.	153	780	144	385	1,462	16.03	7.73
5.01 to 6 p. m.	82	432	105	219	838	9.19	4.43
Total afternoon	1,042	4,771	961	2,346	9,120	100.00	48.24
Total day turn	2,236	10,065	1,993	4,610	18,904	.....	100.00
NIGHT TURN.							
6.01 to 7 p. m.	66	355	97	228	746	16.71	9.40
7.01 to 8 p. m.	79	416	103	25	833	18.66	10.50
8.01 to 9 p. m.	70	408	107	232	827	18.52	10.42
9.01 to 10 p. m.	63	361	102	256	782	17.51	9.86
10.01 to 11 p. m.	48	375	99	217	739	16.55	9.31
11.01 to 12 p. m.	48	240	64	188	538	12.05	6.78
Total first half of night	374	2,155	570	1,366	4,465	100.00	56.27
12.01 to 1 a. m.	48	209	104	139	500	14.41	6.30
1.01 to 2 a. m.	43	294	99	212	648	18.67	8.17
2.01 to 3 a. m.	36	276	81	269	662	19.08	8.34
3.01 to 4 a. m.	46	251	90	194	581	16.74	7.32
4.01 to 5 a. m.	37	254	85	179	555	16.00	6.99
5.01 to 6 a. m.	33	262	62	167	524	15.10	6.60
Total second half of night	243	1,546	521	1,160	3,470	100.00	43.72
Total night turn	617	3,701	1,091	2,526	7,935	.....	100.00
Total reported	2,853	13,766	3,084	7,136	26,839	.....	.....
Not reported	1,135	3,222	177	614	5,148	.....	.....
Grand total	3,988	16,988	3,261	7,750	31,987	.....	.....

[1] This group contains plants averaging less than 500 employees. This distribution by hours was not tabulated by departments.

The contrasts appearing between day and night will first be considered. Wherever the details making up the final aggregate are given for the two periods it will be observed that the variation in the hour of greatest accident occurrence is much less in the day turn than in the night turn. For this there are two explanations: (1) The volume of accidents at night is much less than that in the day, since the working force is at that time considerably diminished. Wherever the volume of night-turn accidents rises to proportions at all comparable with those of the day turn there is a clearly marked tendency for them to fall into a similar distribution. (2) The force at night is of a different character from the day force, partic-

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ularly in the following respect: A large part of the day force are engaged in occupations where the injuries occur to individuals. In the characteristic steel occupations mass accidents are not infrequent. The tendency of these mass accidents is, of course, to disturb in any small group of cases the regularity of distribution. In the day the number of men on duty whose accidents are liable to occur individually is so considerable that there is a strong tendency to quickly submerge the mass accident in the regular order of things. At night those exposed to mass accidents constitute so much larger a proportion of the force on duty that these mass accidents stand out at particular points, and until the aggregate becomes quite large the orderly arrangement does not appear. When the final totals are considered, it will be seen that the afternoon and the second half of the night have a distribution somewhat similar, in each period the third hour showing the greatest number of accidents. The last hour in the afternoon, however, has a much smaller percentage of accidents than the last hour of the night. The consideration which has already been advanced fully accounts for this difference, namely, the working force is considerably decreased about 5 o'clock in the afternoon. No such decrease occurs in the last hour of the night.

The first half of the day and the first half of the night present a rather decided contrast. For the forenoon the peak of accidents comes in the fourth hour; for the night it comes in the second and third hours. While the detailed parts of the table do not show uniformity in this particular, they show that some cause is at work in all departments and in all plants to bring about an earlier peak of accident occurrence the first half of the night. Two things contribute to this—one certainly and the other probably. The first of these is the fact that in many establishments the early hours of the night turn are a period of repair work, during which mechanics are working overtime from their day turns. This raises the working force for these few hours and necessarily increases the accident occurrence. It is also possible to suppose that since these men are working overtime, and often at rush jobs, we may have in their case two factors tending to increase accident occurrence. (1) Their fatigued condition after their regular day of work, and (2) the tendency to hasten the work, both because of their own desire to get away and because these repairs are frequently of an extraordinary character and demand for the satisfactory operation of the mill very speedy completion.

Another cause of an earlier accident peak in the night is suggested by superintendents who are familiar with the situation. They say that the men on night turn do not secure the same amount and the same quality of restful sleep that those may have who are on day turn; that consequently they come to the mills for the night turn in a less satisfactory physical condition than the

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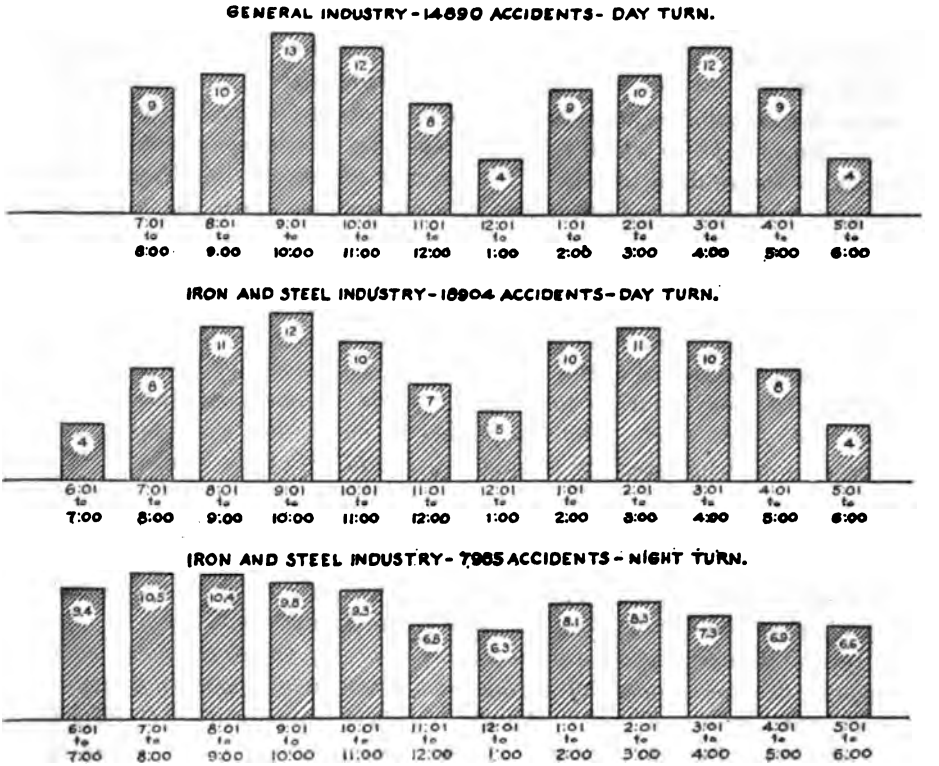
men reporting in the morning, and that this more or less definite lowering of physical tone would tend during the period when they were getting into the swing of the work to bring about a greater number of accidents. It seems reasonable to suppose that this factor has quite a little influence, and with the two factors suggested it is believed that the earlier accident peak in the night turn has a satisfactory explanation.

In the day turn the uniformity of these different groups is striking. Notice, for example, in the table combining the results in the steel

PER CENT OF ACCIDENTS OCCURRING IN EACH HOUR OF THE WORKING DAY IN GENERAL INDUSTRY AND IN IRON AND STEEL INDUSTRY.



industry that the peak of morning accident comes throughout all the groups at exactly the same hour. In the afternoon group in only one of them does it vary from the mean, and this so slightly as to have no significance. The lack of uniformity in the night hours has already been discussed. The accompanying diagram presents some of these facts. The per cents shown in the first section are from a report on the employment of women in the metal trades;[1] those in the other two sections are from the table on page 79.

[1] Report on Condition of Woman and Child Wage-Earners in the United States, Vol. XI: Employment of Women in the Metal Trades, S. Doc. No. 645, 61st Cong., 2d sess., p. 96.

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In the report made to the Senate on the employment of women in the metal trades it was noted that the results were unexpected from two standpoints. First, in the appearance of peaks of accident occurrence in each of the divisions of the working day, when it was predicted that there would be a rise throughout the working period; and, second, in that almost uniformly the number of accidents in the forenoon was greater than in the afternoon. While this arrangement was found to exist in the case of ordinary manufacturing industry, it was possible to anticipate that in an industry varied and of peculiar conditions, such as are found in the steel industry, no such regularity of distribution would be encountered. As these tables embody so large a mass of material from this industry, and as the results have been corroborated by other tabulations of nearly equal volume, this apparently represents a law the reasons for which are a proper subject of inquiry. It is evident that the old idea of relation of fatigue to industrial accident must be materially modified.

In the report[1] to which reference has been made an attempt was made to secure data in regard to the rate of production from hour to hour through the day for possible comparison with the hour of greatest accident occurrence. The case selected was one in which the operators worked entirely independently, the output being governed strictly by the activity of the individual man. These were stamping-press operators upon whose machines there were automatic counters. The record of the pieces produced as shown by the counters was taken from hour to hour and a table constructed showing a curve of production. The result was to show that production increased somewhat steadily throughout the hours of the morning, began at a lower point in the afternoon, and again increased, with a slight falling off at the last hour in the afternoon. This group was of altogether too small volume to be at all decisive, and the correspondence and the differences between this curve of production and the curve of accident suggested the need of further study.

It was desired in the iron and steel industry to secure data with regard to some process of similar character involving not a single man, but a group of men. It will be noticed that in order to afford satisfactory material for such a study the operation must be of a kind which is continuously repeated throughout the hours of work, the extraordinary interruptions must be as few as possible, and it must be possible to determine the number of these repetitions within each hour. After careful consideration it became evident that the operations of the Bessemer steel converter conformed as closely to these conditions as anything occurring in steel-mill practice. The converter is a rarher simple apparatus and maintains a

[1] Report on Condition of Woman and Child Wage-Earners in the United States, Vol. XI: Employment of Women in the Metal Trades, p. 98, et seq.

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degree of constant operation throughout long periods more uniform than any other operation possible to tabulate in the same way. The records of the blower are carefully kept, showing the time when the blow begins and when it ends. This makes it possible to count the number occurring within a given hour and to aggregate counts from day to day.

The records of a plant having three vessels were chosen for consideration. It was possible to cover a period of eight months. During these eight months two of the vessels were operated continuously. The other was used as an auxiliary, and so its operation was decidedly irregular. For that reason attention will be given exclusively to the two vessels operating continuously throughout the period.

Some comment should be made upon the conditions under which these records were made. The Bessemer plant in question employs in the neighborhood of 300 men. In order that the operation may go smoothly and satisfactorily, there must be very closely timed cooperation among all these men. If, then, it is found that the production of this mill shows some definite distribution throughout the hours of the day, it is an indication that not only do men working individually tend to fall into a sort of rythm in their productive activity, but that a large group of men working upon a problem similar to that of the individual stamping-press operator do their work in a similar manner. The data are presented in the following table:

PRODUCTION IN A BESSEMER STEEL MILL DURING A PERIOD OF EIGHT MONTHS, BY HOURS.

Hours.	Number of blows.					
	Day turn.			Night turn.		
	Vessel A.	Vessel B.	Total.	Vessel A.	Vessel B.	Total.
6.01 to 7	606	602	1,208	601	590	1,191
7.01 to 8	638	631	1,269	639	645	1,284
8.01 to 9	613	600	1,213	592	583	1,175
9.01 to 10	571	575	1,146	578	586	1,164
10.01 to 11	644	648	1,292	673	673	1,346
11.01 to 12	679	676	1,355	667	653	1,320
Total, first half	3,751	3,732	7,483	3,750	3,730	7,480
12.01 to 1	623	599	1,222	602	611	1,213
1.01 to 2	594	599	1,193	590	592	1,182
2.01 to 3	668	681	1,349	786	675	1,461
3.01 to 4	713	697	1,410	706	700	1,406
4.01 to 5	583	608	1,191	646	651	1,297
5.01 to 6	605	596	1,201	586	581	1,167
Total, second half	3,786	3,780	7,566	3,916	3,810	7,726
Total for turn	7,537	7,512	15,049	7,666	7,540	15,206

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The aggregated results of these eight months of activity show that there is a high point of production in the last hour of the morning. The preceding hours do not lead up steadily to this high point; but for this there is a definite reason. During the two hours in the middle of this working period certain changes and repairs are regularly made in the apparatus, so that we should expect these two hours to show a somewhat decreased production. Disregarding these two hours, the steps are these: 1,208, 1,269, 1,292, 1,355. In the afternoon production rises to a high point in the fourth hour and then drops off somewhat. In the first half of the night production rises to a high point in the fifth hour; in the second half of the night, in the third hour.

So many factors enter into the determination of these totals that it is altogether probable that the group of data assembled is not sufficiently large to wipe out the irregularities. Enough appears in these figures to indicate that production on this large and complicated scale runs a cycle similar to that observed in the individual stamping-press operators.

For an entirely satisfactory comparison of the distribution of accidents through the hours of the day with the curve of production through the hours of the day, obviously the data should be from precisely the same establishment and covering precisely the same period of time. Furthermore, comparisons in a considerable number of establishments covering a considerable period of time would be necessary before it would be safe to draw definite conclusions. The production data presented above are from one Bessemer department, covering a period of 8 months. The best available accident data for comparison are from the Bessemer department of another plant, covering a period of 6 years.[1] The departments in the two cases employed almost exactly the same number of men and the physical conditions and methods of operation are substantially alike in all respects. The data, therefore, while derived from different sources, justify a comparison. The most striking fact disclosed by this comparison is that in each division of the working period, except the last half of the night, the peak of accident occurrence appears in an earlier hour than does the peak of production.

A satisfactory explanation of the agreements and differences found in the above comparison is impossible at the present time. The group of accidents making up the accident curve is rather small and on that account of less weight, but it covers a period of 6 years, and, moreover, seems to be in accord with the accident curve in the steel industry as a whole and in industries generally. A consideration of such comparisons as are made above immediately suggests many questions as to their significance as bearing upon the relation between

[1] See p. 77.

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production and fatigue and accidents and fatigue, but it is clear from the limitations of the material that the answer to these questions can not yet be made. Apparently it might be expected that the effects of fatigue would show themselves in the rate of production at an earlier hour than in the rate of accident occurrence, but in the figures above the peak of production is found on the whole somewhat later than that of accidents. From such a small body of data it is scarcely possible to expect definite conclusions. The comparisons, however, should suggest the danger of conclusions in regard to the relation of fatigue and accidents without a thorough study of all the circumstances.

In the diagram on page 86 is presented a comparison of the production at each hour of the day and night in the Bessemer department for which figures were available for 8 months, with the number of accidents occurring at the same hour in all the steel works (Bessemer and open hearth combined) reporting. It will be noticed, according to this comparison, that in each 6-hour period the peak of accident occurrence precedes that of production.

In answer to a question regarding the possible relation of age to the accident curve, the following table has been prepared. It shows the curve for those 22 years of age and under and those 30 years and over. It is evident from the table that there is no discernible modification of the curve to be attributed to age.

DISTRIBUTION OF INJURIES THROUGH THE DAY, BY AGE GROUPS.

[The figures relate to 1 plant for a period of six years.]

Hours.	Number of injuries to—	
	Employees 22 years of age and under.	Employees 30 years of age and over.
6.01 to 7 a. m.	25	62
7.01 to 8 a. m.	56	122
8.01 to 9 a. m.	72	114
9.01 to 10 a. m.	64	150
10.01 to 11 a. m.	64	134
11.01 a. m. to 12 m	37	91
Total, forenoon	318	673
12.01 to 1 p. m.	30	70
1.01 to 2 p. m.	41	158
2.01 to 3 p. m.	68	167
3.01 to 4 p. m.	53	129
4.01 to 5 p. m.	49	129
5.01 to 6 p. m.	26	65
Total, afternoon	267	718
Total, day turn	585	1,391

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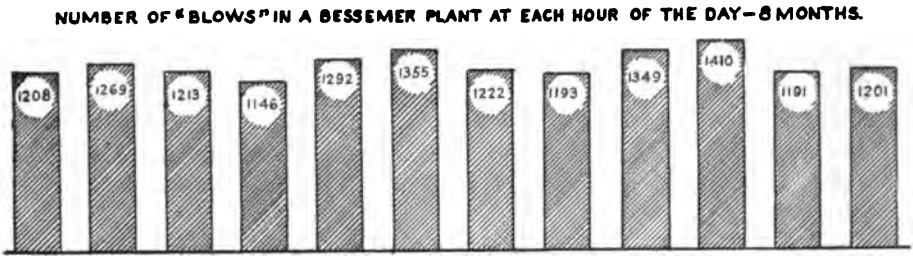
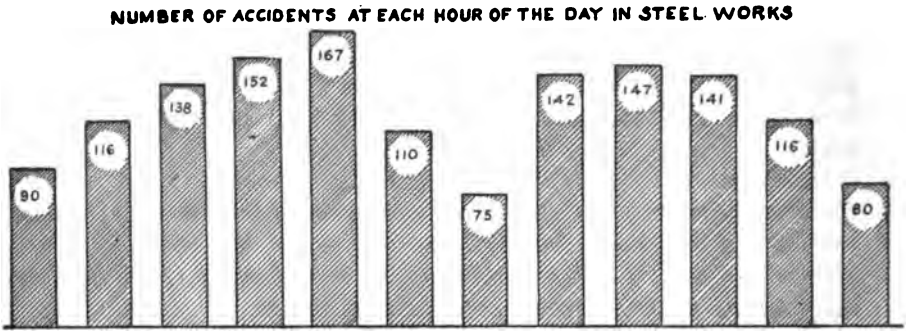
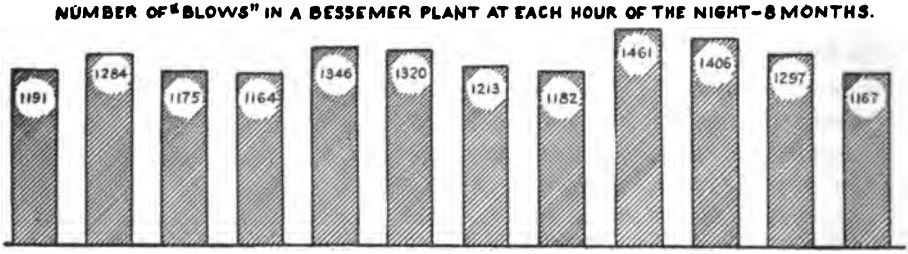
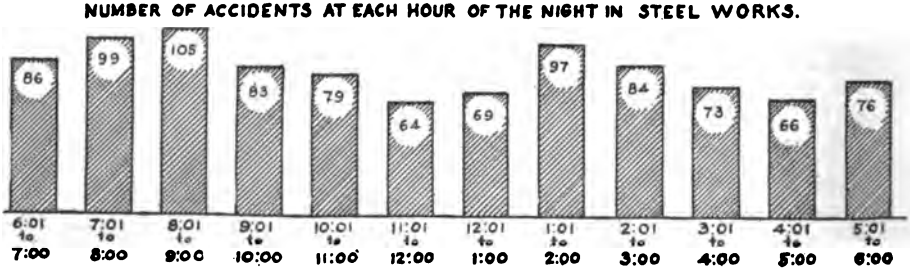
There are several other topics, such as the effect upon the accident rate of the long turn in blast furnaces and the relation between accident occurrence in night and day, which should logically be con-









sidered in this connection. Since, however, the material available for the discussion of these topics is largely derived from the history of a single large plant whose experience is to form the subject of a later chapter, their discussion will be deferred.

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FATAL ACCIDENTS.

GENERAL DISCUSSION.

The fatalities occurring in industrial employments have frequently been regarded as an adequate measure of industrial hazard. For a very large number of employees, or for a series of years, this view is justified. In an industry subject to mass accidents such injuries are liable to great fluctuations from year to year, and a single year's record can not, therefore, be taken, apart from less severe accidents, as a fair indication of the real conditions. In the two years to which attention is being directed there occurred, in the 334 plants which reported, 569 cases of fatal injury, 214 in the year ending June 30, 1909, and 355 in the year ending June 30, 1910. Although the number in the second year is greater the rate is probably less since available figures from many large companies show a decline in rates. The plants from which these reports were received employed at least 81 per cent of all the work people engaged in the industry, as limited for purposes of this inquiry. The following table presents the data with regard to these cases by years, departments, and causes of death:

FATAL ACCIDENTS, BY DEPARTMENTS AND CAUSES, TWO YEARS ENDING JUNE 30, 1910.

NUMBER.

Departments and years.	Burns from hot metal.	Burns from steam and water.	Burns not specified.	Electric shock.	Crushing injury.	Falling objects.	Flying objects.	Falls of worker.	Belts, gears, etc.	Asphyxia.	Unclassified.	Not reported.	Total.
1909.													
Blast furnaces	8	1	8	1	8	7	.....	6	1	12	8	.....	60
Steel works	6	.....	1	.....	9	6	.....	2	.....	.....	3	1	28
Rolling mills	2	.....	2	.....	10	6	.....	.....	.....	.....	2	.....	22
Foundries	1	.....	.....	.....	1	.....	.....	.....	.....	.....	2	2	6
Yards	.....	1	.....	.....	25	1	1	1	.....	.....	7	.....	36
Electrical	.....	.....	.....	2	4	.....	.....	2	.....	.....	.....	.....	8
Mechanical	1	.....	1	2	7	3	.....	11	.....	5	5	1	36
Miscellaneous	.....	3	.....	1	7	2	.....	.....	1	1	3	.....	18
Total	18	5	12	6	71	25	1	22	2	18	30	4	214
1910.													
Blast furnaces	8	2	5	.....	21	8	1	8	.....	6	6	4	69
Steel works	3	1	.....	.....	23	8	.....	2	.....	.....	11	3	51
Rolling mills	5	1	2	1	22	9	4	2	.....	.....	11	.....	57
Foundries	1	.....	.....	.....	4	5	.....	.....	.....	.....	2	.....	12
Yards	1	1	.....	.....	33	6	6	4	.....	1	20	1	73
Electrical	.....	.....	.....	2	4	.....	.....	2	.....	1	2	.....	11
Mechanical	1	.....	2	2	12	2	.....	7	.....	2	14	.....	42
Miscellaneous	.....	.....	3	.....	8	6	1	5	1	.....	11	5	40
Total	19	5	12	5	127	44	12	30	1	10	77	13	355
1909 AND 1910.													
Blast furnaces	16	3	13	1	29	15	1	14	1	18	14	4	129
Steel works	9	1	1	.....	32	14	.....	4	.....	.....	14	4	79
Rolling mills	7	1	4	1	32	15	4	2	.....	.....	13	.....	79
Foundries	2	.....	.....	.....	5	5	.....	.....	.....	.....	4	2	18
Yards	1	2	.....	.....	58	7	7	5	.....	1	27	1	109
Electrical	.....	.....	.....	4	8	.....	.....	4	.....	1	2	.....	19
Mechanical	2	.....	3	4	19	5	.....	18	.....	7	19	1	78
Miscellaneous	.....	3	3	1	15	8	1	5	2	1	14	5	58
Total	37	10	24	11	198	69	13	52	3	28	107	17	569

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FATAL ACCIDENTS, BY DEPARTMENTS AND CAUSES, TWO YEARS ENDING JUNE 30, 1910—Concluded.

PER CENT IN EACH DEPARTMENT.

Departments and years.	Burns from hot metal.	Burns from steam and water.	Burns not specified.	Electric shock.	Crushing injury.	Falling objects.	Flying objects.	Falls of worker.	Belts, gears, etc.	Asphyxia.	Unclassified.	Not reported.	Total.
1909.													
Blast furnaces	44.4	20.0	66.7	16.7	11.3	28.0	.....	27.3	50.0	66.7	26.7	.....	28.0
Steel works	33.3	.....	8.3	.....	12.7	24.0	.....	9.1	.....	.....	10.0	25.0	13.1
Rolling mills	11.1	.....	16.7	.....	14.1	24.0	.....	.....	.....	.....	6.7	.....	10.3
Foundries	5.6	.....	.....	.....	1.4	.....	.....	.....	.....	.....	6.7	50.0	2.8
Yards	.....	20.0	.....	.....	35.2	4.0	100.0	4.5	.....	.....	23.3	.....	16.8
Electrical	5.6	.....	.....	33.3	5.6	.....	.....	9.1	.....	.....	.....	.....	3.7
Mechanical	.....	.....	8.3	33.3	9.9	12.0	.....	50.0	.....	27.8	16.7	25.0	16.8
Miscellaneous	.....	60.0	.....	16.7	9.9	8.0	.....	.....	50.0	5.6	10.0	.....	8.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1910.													
Blast furnaces	42.1	40.0	41.7	.....	16.5	18.2	8.3	26.7	.....	60.0	7.8	30.8	19.4
Steel works	15.8	20.0	.....	.....	18.1	18.2	.....	6.7	.....	.....	14.3	23.1	14.4
Rolling mills	26.3	20.0	16.7	20.0	17.3	20.5	33.3	6.7	.....	.....	14.3	.....	16.1
Foundries	5.3	.....	.....	.....	3.1	11.4	.....	.....	.....	.....	2.6	.....	3.4
Yards	5.3	20.0	.....	.....	26.0	13.6	50.0	13.3	.....	10.0	26.0	7.7	20.6
Electrical	.....	.....	.....	40.0	3.1	.....	.....	6.7	.....	10.0	2.6	.....	3.1
Mechanical	5.3	.....	16.7	40.0	9.4	4.5	.....	23.3	.....	20.0	18.2	.....	11.8
Miscellaneous	.....	.....	25.0	.....	6.3	13.6	8.3	16.7	100.0	.....	14.3	38.5	11.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1909 AND 1910.													
Blast furnaces	43.2	30.0	54.2	9.1	14.6	21.7	7.7	26.9	33.3	64.3	13.1	23.5	22.7
Steel works	24.3	10.0	4.2	.....	16.2	20.3	.....	7.7	.....	.....	13.1	23.5	13.9
Rolling mills	18.9	10.0	16.7	9.1	16.2	21.7	30.8	3.8	.....	.....	12.1	.....	13.9
Foundries	5.4	.....	.....	.....	2.5	7.2	.....	.....	.....	.....	3.7	11.8	3.2
Yards	2.7	20.0	.....	.....	29.3	10.1	53.8	9.6	.....	3.6	25.2	5.9	19.2
Electrical	.....	.....	.....	36.4	4.0	.....	.....	7.7	.....	3.6	1.9	.....	3.3
Mechanical	5.4	.....	12.5	36.4	9.6	7.2	.....	34.6	.....	25.0	17.8	5.9	13.7
Miscellaneous	.....	30.0	12.5	9.1	7.6	11.6	7.7	9.6	66.7	3.6	13.1	29.4	10.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

PER CENT FROM EACH CAUSE.

1909.													
Blast furnaces	13.3	1.7	13.3	1.7	13.3	11.7	.....	10.0	1.7	20.0	13.3	.....	100.0
Steel works	21.4	.....	3.6	.....	32.1	21.4	.....	7.1	.....	.....	10.7	3.6	100.0
Rolling mills	9.1	.....	9.1	.....	45.5	27.3	.....	.....	.....	.....	9.1	.....	100.0
Foundries	16.7	.....	.....	.....	16.7	.....	.....	.....	.....	.....	33.3	33.3	100.0
Yards	.....	2.8	.....	.....	69.5	2.8	2.8	2.8	.....	.....	19.4	.....	100.0
Electrical	.....	.....	.....	25.0	50.0	.....	.....	25.0	.....	.....	.....	.....	100.0
Mechanical	2.8	.....	2.8	5.6	19.4	8.3	.....	30.6	.....	13.9	13.9	2.8	100.0
Miscellaneous	.....	16.7	.....	5.6	38.9	11.1	.....	.....	5.6	5.6	16.7	.....	100.0
Total	8.4	2.3	5.6	2.8	33.2	11.7	.5	10.3	.9	8.4	14.0	1.9	100.0
1910.													
Blast furnaces	11.6	2.9	7.2	.....	30.4	11.6	1.4	11.6	.....	8.7	8.7	5.8	100.0
Steel works	5.9	2.0	.....	.....	45.1	15.7	.....	3.9	.....	.....	21.6	5.9	100.0
Rolling mills	8.8	1.8	3.5	1.8	38.6	15.8	7.0	3.5	.....	.....	19.3	.....	100.0
Foundries	8.3	.....	.....	.....	33.3	41.7	.....	.....	.....	.....	16.7	.....	100.0
Yards	1.4	1.4	.....	.....	45.2	8.2	8.2	5.5	.....	1.4	27.4	1.4	100.0
Electrical	.....	.....	.....	18.2	36.4	.....	.....	18.2	.....	9.1	18.2	.....	100.0
Mechanical	2.4	.....	4.8	4.8	28.6	4.8	.....	16.7	.....	4.8	33.3	.....	100.0
Miscellaneous	.....	.....	7.5	.....	20.0	15.0	2.5	12.5	2.5	.....	27.5	12.5	100.0
Total	5.4	1.4	3.4	1.4	35.8	12.4	3.4	8.5	.3	2.8	21.7	3.7	100.0
1909 AND 1910.													
Blast furnaces	12.4	2.3	10.1	0.8	22.5	11.6	0.8	10.9	0.8	14.0	10.9	3.1	100.0
Steel works	11.4	1.3	1.3	.....	40.5	17.7	.....	5.1	.....	.....	17.7	5.1	100.0
Rolling mills	8.9	1.3	5.1	1.3	40.5	19.0	5.1	2.5	.....	.....	16.5	.....	100.0
Foundries	11.1	.....	.....	.....	27.8	27.8	.....	.....	.....	.....	22.2	11.1	100.0
Yards	.9	1.8	.....	.....	53.2	6.4	6.4	4.6	.....	.9	24.8	.9	100.0
Electrical	.....	.....	.....	21.1	42.1	.....	.....	21.1	.....	5.3	10.5	.....	100.0
Mechanical	2.6	.....	3.8	5.1	24.4	6.4	.....	23.1	.....	9.0	24.3	1.3	100.0
Miscellaneous	.....	5.2	5.2	1.7	25.9	13.8	1.7	8.6	3.4	1.7	24.1	8.6	100.0
Total	6.5	1.8	4.2	1.9	34.8	12.1	2.3	9.1	.5	4.9	18.8	3.0	100.0

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Considering the portion of the table showing the combined figures for the two years it will be observed that among the causes of death burns of various sorts constitute an important element. In blast furnaces 24.8 per cent of the fatalities were due to this cause, while the next most important cause, crushing injury, had 22.5 per cent. In steel works 14 per cent of the cases were due to burns, 40.5 per cent to crushing injury. In rolling mills 15.3 per cent were due to burns and 40.5 per cent to crushing injury. In foundries 11.1 per cent were due to burns and 27.8 per cent to crushing injury. In the yard operations the crushing injuries far outnumbered any other cause, constituting 53.2 per cent.

Two causes of injury—electricity and transmission gear—which have been generally regarded as important are shown by this tabulation to be of relative insignificance.

The large introduction of the use of electric power has naturally been regarded as a source of great danger, both to those particularly concerned in caring for the electrical apparatus and incidentally to other workers. The reason for the impression of the highly dangerous nature of this employment is that accidents, when they occur, are usually of a very striking character. A lineman repairing an overhead wire may come in contact with a wire which carries a current and be instantly killed. The accidents almost invariably attract considerable attention.

No other industry has introduced electric power on a scale at all comparable with the iron and steel industry. As a result all of the dangers which are connected with the use of this form of energy are found in the steel mills. In the year 1910 two electrical workers were killed by electric shock. The number engaged during 1910 in electrical work was 2,500. This would give a rate for the year of 0.80 per 1,000.

Much attention has recently been bestowed upon injuries resulting from belts, gears, and other forms of transmission apparatus. The dangers from these are quite obvious, and both in safety rules and legal enactments provisions for their safeguarding are always found. The number of accidents from such causes occurring in a large plant during each year from 1905 to 1910 is shown in Chapter II, page 140.

The causes of death which follow in order after crushing injury and burns are: Falling objects, with 12.1 per cent, and falls of the worker, with 9.1 per cent. The line between crushing injury and injury by falling objects is not easily drawn, and probably cases belonging in one group have been included in the other. The group included under falling objects was introduced in the first place because of the special danger which assails workmen about a blast furnace. Fre-

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quently quantities of material are ejected by the furnace and these falling upon the workmen produce serious or fatal injury. It appears that while blast furnaces had 11.6 per cent of fatalities from this cause, steel works had 17.7 per cent and rolling mills 19 per cent.

A particular danger of the blast furnace is emphasized by the number of cases of death due to asphyxia. Outside of the blast furnaces this cause of death is not very important. Ten deaths from this cause occurred in the two years in other departments. These were mostly repair men working in gas-engine houses. Of all deaths from asphyxia 64.3 per cent occurred in blast furnaces. These constitute 14 per cent of blast-furnace fatalities.

In 155 establishments, showing 158,604 positions on the pay rolls, it was possible to determine with some exactness the equivalent number of 300-day workers.[1] They numbered 146,983, or 92.7 per cent of the positions shown. In 1910 the reporting plants showed upon their pay rolls 210,614 positions. Assuming that they have the same proportion of 300-day workers as did the plants for which determination could be made would give 195,239. In the year 1910 all operating plants had 355 fatalities. The rate for that year, calculated on the above basis, would be 1.82 per 1,000.

SIGNIFICANCE OF THE FATALITY RATE.

Reference has been made to the fact that fatality rates are an uncertain indication of the real conditions. Before leaving the discussion of the fatality tables it is desirable to indicate more exactly the reasons why such rates may be misleading. Whenever a relatively small group is dealt with, very slight changes produce very pronounced results. In coal mining, for example, it has been shown in a recent report that in restricted localities for a single year a large mass accident may put the district into an altogether different class from that which its normal conditions would justify.[2] For example, in the western section of the United States the average fatality rate for coal-mine employees from 1889 to 1908 was 6.40 per 1,000, but the year 1900 had a rate of 23.45, the highest year aside from this (1896) having 8.82. The Pacific coast section had rates of 10.49 in 1892, 14.66 in 1901, and 20.71 in 1902. The average rate of this section for the whole period was 7. The cause of these abnormally high rates was in each case one or more mass accidents.

In any industry subject to mass accidents, violent and misleading fluctuation of rates is likely to occur. The iron and steel industry is by no means as subject to this class of accidents as mining. The largest number of deaths from a single accident which came under observation in the course of this investigation was 15, while in

[1] For explanation of 300-day workers, see pp. 21 and 22.
[2] Bulletin of the U. S. Bureau of Labor No 90, p. 450.

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mining accidents causing hundreds of deaths are not uncommon. Where, however, a single accident may produce from 10 to 20 fatalities the rate will necessarily be of an uncertain character. To illustrate, in one large establishment two mass accidents, each causing a number of deaths, occurred in a single calendar year—one early in the year and one in November or December. The result was that the fatality rate for that year was very high. It is evident that had the record year ended in June instead of December 31, these mass accidents would not have fallen in the same record year. If this had been the case the rates for three years would have been nearly uniform. As it is, the year in which the two mass accidents happened to occur stands out with a much higher rate than either the year preceding or the year following. The fatality rate in this case would give the impression of a very bad condition, the fact being that this particular year was in many ways a decided improvement over the preceding year and not materially less satisfactory than the one following it.

Wherever conditions are such that simple variations of classification or the effect of unavoidable calamity may so largely modify the rates, it is evident that they must be used with the greatest caution. Throughout this report the fatality rates are presented because they are important matters of information, but they should, whenever possible, be considered in connection with the general accident rate, and if the fatality rate and the general accident rate are contradictory the general rate should be regarded as a fairer measure of the real accident hazard.

It may be said of rates in general that their significance is largely determined by the size of the groups for which they are calculated. In a small group or department of an industry accidents may be so influential that it is doubtful whether it is ever justifiable to present the situation in the form of rates. Desiring to analyze the situation as closely as possible and yet to avoid the difficulties indicated above, it has been the rule to present rates for no group containing less than 1,000 workers. In a few instances, for special reasons, numbers slightly under this limit have been used, but usually the groups are not only of this size, but considerably in excess.

FATAL ACCIDENTS IN EACH DEPARTMENT, BY OCCUPATIONS AND CAUSES.

In the following discussion is presented a series of tables showing by occupations for each department the number of fatal accidents due to each specified cause for the two years ending June 30, 1910. It is desirable to offer some comment upon the occupational dangers suggested by these tables.

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BLAST FURNACES.

The information for blast furnaces is first presented. The following table shows for 129 fatal accidents occurring in this department during the two years under discussion, the number happening in each occupation by causes in detail, together with the per cent of the total number happening in each occupation and the per cent due to each cause:

FATAL ACCIDENTS IN BLAST FURNACES, BY OCCUPATIONS AND CAUSES, TWO YEARS ENDING JUNE 30, 1910.

Occupations.	Burns from hot metal.	Burns from steam and water.	Burns not specified.	Crushing injury.	Falling objects.	Flying objects.	Falls of worker.	Belts, gears, etc.	Asphyxia.	Unclassified.	Not reported.	Total. Number.	Total. Per cent in each occupation.
Boiler makers and helpers	1						2			2		5	3.9
Bottom fillers			1	3	1							5	3.9
Bricklayers				1								1	.8
Cinder snappers	1		1		1		1			1		5	3.9
Clay men				1								1	.8
Cranemen				1								1	.8
Engineers													
Foremen									1			1	.8
Gas washers									2			2	1.6
Hot-blast men					1				1			2	1.6
Keepers and helpers	4		1	1	1				2	1	1	11	8.5
Laborers	7	3	7	16	7	1	4		6	3	2	56	43.4
Millwrights							1	1	1	2		5	3.9
Oilers	3						1		1			5	3.9
Pipe fitters							1		2			3	2.3
Riggers				3			2					5	3.9
Stove tenders					1							1	.8
Top fillers				1	1		1		1			4	3.1
Unclassified			3	2	2		1		1	6	1	16	12.4
Total	16	3	13	29	15	1	14	1	18	15	4	129	100.0
Per cent from each cause	12.4	2.3	10.1	22.5	11.6	0.8	10.9	0.8	14.0	11.6	3.1	100.0	

The occupations of this department fall into three general groups: First, stocking operations, including bottom fillers, top fillers, cagers, hoist men, scale-car operators, etc.; second, cast-house operations, including bar and clay men, keepers and helpers, cinder snappers, etc.; third, accessory operations, including oilers and greasers, common labor, etc. In the first group it appears from observation that the laborers known as "bottom fillers" are exposed to the greatest danger. These men take the material such as ore, coke, and limestone from the bins and wheel it in barrows to the hoist, by which it is carried to the top of the furnace. The fatalities among them were 1 due to burns, 3 due to crushing injury, and 1 due to falling objects. The causes of death in these cases indicate quite clearly the nature of the hazard. In cases where the material is taken from stock piles it may happen that the removal of the stock from the base of the pile loosens a mass

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of material which rushes down upon the workers and results in death from crushing injury.

Among other stocking laborers the "top fillers," who, in the old-style furnaces, are engaged at the top of the furnace in emptying barrows into the furnace hopper, are much exposed. One was killed by crushing injury, 1 by falling objects, 1 fell from the furnace top, and 1 was asphyxiated. While these deaths are few in number, if they could be compared with the number of men still engaged in this occupation, it would appear that their hazard is very great. An illustration will serve to emphasize this fact. A large furnace of the old type was operating in an unsatisfactory manner. In the effort to correct the irregularity an unusual number of men were at work on the top. Without warning the furnace exploded, and 12 of the men engaged in top filling were burned to death. In view of the extreme hazard of this occupation, it is satisfactory to note that a decreasing proportion of furnaces are stocked by this method.

Among the cast-house workers severe burns are naturally the greatest cause of fatal injury. The "cinder snapper" has charge of the periodical tapping of the cinder-notch. This opening is at a higher level than that from which the molten iron is drawn, and when the accumulating material within the furnace brings the slag which floats upon the top of the iron up to a certain level the cinder snapper must open the notch and permit the slag to flow down a runner from which it is delivered either into a slag car or into a granulating tank. Two of these employees suffered fatal burns, 1 was killed by falling objects, 1 fell from a height, and 1 died from unclassed injury. In this connection it is proper to speak of the special danger about blast furnaces from falling objects. Until very recently the "slips" and explosions within the furnace were always accompanied by the ejection of a greater or less quantity of stock from the furnace top. The masses thrown out were of considerable size and weight and were also hot to a degree which rendered them dangerous. These masses falling from a height of 100 feet or more would inflict a blow sufficient to cause serious injury and in numerous cases death. The fall of the cinder snapper resulting in death occurred very probably as a result of failure properly to rail the elevated cast-house floor. The keeper and his helpers have to do with the opening of the iron notch and attending to the flow of the molten metal. Five of these were injured by the hot metal, while 2 of them died from asphyxia.

It has not been possible to assign definitely to either of the groups enumerated above the common laborers employed about the furnace. Probably the 17 who died as a result of burns were employed on the cast-house floor or its vicinity, while the 28 who were killed by crushing injury and falling and flying objects were, in all

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probability, stocking laborers. Of all deaths 43.4 per cent were those of common laborers. This is a large percentage. If, however, it were possible to calculate a rate for these employees, it would probably appear that other employments are proportionately more dangerous, as, for example, the keepers and their helpers.

Among the accessory occupations, boiler makers, pipe fitters, riggers, and millwrights are most frequently fatally injured. These four occupations have 14 per cent of all the fatalities. The work of these occupations is carried on in such relations to the furnace that workers are seriously exposed to the poisonous gases. This exposure not only entails direct danger of asphyxia, but may often be the cause of the worker losing control of himself and falling. For example, two of the three pipe fitters died from asphyxia, while 1 pipe fitter and 2 riggers suffered fatal falls probably brought about by the inhalation of the deadly gas.

It will be found in all the departments that the oilers and greasers are exposed to serious danger, usually due to the fact that they must approach moving parts of machinery, in which they are in danger of being caught, but in the present instance the five fatalities which occurred among this class of workers were from unusual dangers—3 were due to burns, 1 to a fall, and 1 to asphyxia.

Of all fatalities occurring in blast furnaces 24.8 per cent are due to burns, 22.5 per cent to crushing injury, 11.6 per cent to falling objects, 10.9 per cent to falls of the workers, and 14 per cent to asphyxia.

It has already been pointed out that asphyxia is in some measure responsible for the occurrence of other accidents. This is probably true throughout the list since the physical condition brought about by carbon monoxide poisoning favors the occurrence of all the other forms of accident. The presence of this gas may therefore be regarded as the most serious menace to the blast-furnace worker. It not only contributes a high percentage of fatal cases by its direct action and, as explained, has to do with the occurrence of other accidents, but its constant action when not accompanied by serious immediate results undermines the health and lowers the efficiency of the worker.

STEEL WORKS.

The two methods of steel making, Bessemer and open-hearth, are so different that a separate treatment of their fatalities would be justified. The number of them is, however, so small that an analysis on that basis would not convey any useful information. The following table shows the data for the 79 fatal accidents occurring during the two years.

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FATAL ACCIDENTS IN STEEL WORKS, BY OCCUPATIONS AND CAUSES, TWO YEARS ENDING JUNE 30, 1910.

Occupations.	Burns from hot metal.	Burns from steam and water.	Burns not specified.	Crushing injury.	Falling objects.	Flying objects.	Falls of worker.	Belts, gears, etc.	Asphyxia.	Unclassified.	Not reported.	Total.	
												Number.	Per cent in each occupation.
Bottom makers	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1	1.3
Chargers	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1	1.3
Cindermen	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1	1.3
Crane inspectors	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1	1.3
Cranemen	.....	.....	.....	3	.....	.....	.....	.....	.....	1	.....	4	5.1
Dynamiters	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1	1.3
Door operators	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1	1.3
Foremen	2	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	3	3.8
Hoist men	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1.3
Laborers	.....	.....	1	14	10	.....	4	.....	.....	5	.....	34	43.0
Ladle men	.....	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	2	2.5
Melters' helpers	3	1	.....	3	.....	.....	.....	.....	1	1	.....	8	10.1
Oilers	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1	1.3
Pitmen	1	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	2	2.5
Repair men	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1	1.3
Riggers	.....	.....	.....	2	.....	.....	.....	.....	.....	1	.....	3	3.8
Scrap men	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1.3
Stockers	1	.....	.....	3	.....	.....	.....	.....	.....	1	.....	5	6.2
Stool cleaners	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	1	1.3
Vessel men	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	1	1.3
Unclassified	.....	.....	.....	1	.....	.....	.....	.....	.....	1	4	6	7.6
Total	9	1	1	32	14	.....	4	.....	.....	14	4	79	100.0
Per cent from each cause	11.4	1.3	1.3	40.5	17.7	.....	5.1	.....	.....	17.7	5.1	100.0	.....

Common laborers about steel works suffer 43 per cent of the fatal injuries. The next group in order are the melters' helpers and ladlemen, who together have 12.6 per cent of the fatalities. Among the laborers crushing injury and falling objects are the most serious, 14 being killed by the first and 10 by the second. Among ladle men and melters' helpers burns are naturally important, 4 suffering from this cause, but crushing injury and falling objects caused 5 deaths. The stockers who handle the raw material are next in hazard with 5 deaths, or 6.2 per cent of the total fatalities. The remaining cases of fatal injury are distributed so irregularly among the different classes of employees that special comment is not significant. In the steel works 14 per cent of the injuries are due to burns, 40.5 per cent to crushing injury, 17.7 per cent to falling objects, 5.1 per cent to falls, and 17.7 per cent to unclassed injuries.

ROLLING MILLS.

In the discussion of disabling accidents the rolling mills are considered under two heads—mechanically operated and hand operated. The same division would be desirable for the fatal cases, but the data were not available in this form. The table following presents the data for the 79 fatal accidents in all rolling mills for which reports were secured.

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FATAL ACCIDENTS IN ROLLING MILLS, BY OCCUPATIONS AND CAUSES, TWO YEARS ENDING JUNE 30, 1910.

Occupations.	Burns from hot metal.	Burns from steam and water.	Burns not specified.	Crushing injury.	Falling objects.	Flying objects.	Falls of worker.	Belts, gears, etc.	Asphyxia.	Unclassified.	Not reported.	Total.	
												Number.	Per cent in each occupation.
Crane hookers	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	1	1.3
Cranemen	.....	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	2	2.5
Drag downs	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1.3
Drag outs	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1	1.3
Foremen	1	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	2	2.5
Heaters and helpers	.....	.....	.....	1	1	.....	.....	.....	.....	2	.....	4	5.1
Hook ups	2	.....	.....	1	.....	1	.....	.....	.....	.....	.....	4	5.1
Hotbed men	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1	1.3
Laborers	.....	1	2	9	8	1	.....	.....	.....	2	.....	23	29.1
Lever men	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	1	1.3
Markers	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1	1.3
Oilers and greasers	1	.....	1	4	1	.....	.....	.....	.....	2	.....	9	11.9
Riggers	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1	1.3
Rollers	1	.....	.....	1	.....	2	.....	.....	.....	.....	.....	4	5.1
Roll hands	1	.....	.....	.....	1	.....	1	.....	.....	.....	.....	3	3.8
Shearmen and helpers	.....	.....	.....	4	.....	.....	.....	.....	.....	4	.....	8	10.1
Stampers	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1	1.3
Straighteners	.....	.....	.....	1	.....	.....	.....	.....	.....	1	.....	2	2.5
Tongs men	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1	1.3
Unclassified	.....	.....	1	5	1	.....	.....	.....	.....	2	.....	9	11.4
Total	7	1	4	32	15	4	2	.....	.....	14	.....	79	100.0
Per cent from each cause	8.9	1.3	5.1	40.5	19.0	5.1	2.5	.....	.....	17.7	.....	100.0	.....

The fatalities in these mills may be best presented by following the course of the material. It arrives at the mills in the shape of ingots from the steel works, or in the form of blooms and billets already subjected to a preliminary rolling. In any case the heaters and their helpers are the first to handle the material. During the two years 4 such employees were killed—1 by crushing injury, 1 by falling objects, and 2 by unclassed injury. The men engaged in these occupations are exposed necessarily to the hazard incident to the moving of large masses of material. The train of ingot cars coming from the steel works may strike one of them, or the ingot lifted by the charging crane may fall. The occupation of heaters has few hazards. They watch the steel in the heating furnaces and direct its removal when brought to the right temperature. This being essentially a supervising occupation does not expose them to serious hazard.

The occupation of roller varies greatly in the different mills. In the large mechanical mills he is a superintendent rather than a workman, but in the smaller hand-operated mills he not only has charge of the work but actually participates in it. Four of these men were killed during the two years, 1 by a burn from hot metal, 1 by crushing injury, and 2 by flying objects. Of those directly assisting who are grouped in the table under the headings "roll hands" and "hook ups," 7 were fatally injured, 3 of them by hot-metal burns, 1

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by crushing injury, 1 by falling objects, 1 by flying objects, and 1 by a fall. Naturally the proportion of hot-metal burns to men immediately engaged in the handling of red-hot masses of steel is very high. Among those who handle metal after it passes the rolls the high proportion of accidents is among shearmen and their helpers. They have 10.1 per cent of the fatal cases. Common labor here, as elsewhere, has a very high proportion of the fatalities—29.1 per cent. Of the 23 deaths of laborers 3 were due to burns, 9 to crushing injury, 8 to falling objects, 1 to flying objects, and 2 to unclassed injury. In the rolling mills 15.3 per cent of the cases were due to burns, 40.5 per cent to crushing injury, 19 per cent to falling objects, 5.1 per cent to flying objects, 2.5 per cent to falls, and 17.7 per cent to unclassed injuries.

MECHANICAL OPERATIONS.

The following table presents the causes of the 78 fatal accidents occurring in mechanical operations during the two years, together with the occupations affected:

FATAL ACCIDENTS IN MECHANICAL OPERATIONS, BY OCCUPATIONS AND CAUSES, TWO YEARS ENDING JUNE 30, 1910.

Occupations.	Burns from hot metal.	Burns from steam and water.	Burns not specified.	Crushing injury.	Falling objects.	Flying objects.	Falls of worker.	Belts, gears, etc.	Asphyxia.	Unclassified.	Not reported.	Total. Number.	Total. Per cent in each occupation.
Boiler makers and helpers	.....	.....	.....	2	1	.....	1	.....	.....	3	.....	7	9.0
Bricklayers and helpers	.....	.....	.....	.....	.....	.....	1	.....	2	3	.....	6	7.7
Carpenters and helpers	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	2	2.6
Foremen	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1	1.3
Handy men	.....	.....	.....	1	.....	.....	.....	.....	.....	2	.....	3	3.8
Laborers	1	.....	.....	.....	1	.....	1	.....	.....	1	.....	4	5.1
Machine hands	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1	1.3
Machinists and helpers	.....	.....	1	4	2	.....	3	.....	3	1	.....	14	17.9
Millwrights and helpers	.....	.....	.....	5	.....	.....	1	.....	.....	4	1	11	14.1
Painters	.....	.....	1	.....	.....	.....	7	.....	.....	2	.....	10	12.8
Pipe fitters and helpers	1	.....	1	2	.....	.....	.....	.....	1	.....	.....	5	6.4
Repair men	.....	.....	.....	2	.....	.....	.....	.....	.....	2	.....	4	5.1
Riggers	.....	.....	.....	2	1	.....	3	.....	.....	1	.....	7	9.0
Riveters	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1	1.3
Unclassified	.....	.....	.....	.....	.....	.....	1	.....	1	.....	.....	2	2.6
Total	2	.....	3	19	5	.....	18	.....	7	23	1	78	100.0
Per cent from each cause	2.6	.....	3.8	24.4	6.4	.....	23.1	.....	9.0	29.5	1.3	100.0	.....

This group of workers consists almost entirely of skilled men. The common laborers employed in connection with these mechanical activities are comparatively few. Four laborers lost their lives in this department. The greatest hazard to mechanics is in connection

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with the repair operations. It is frequently desirable, and from the mill superintendent's standpoint necessary, to repair machines which are in action. Frequently also the arrangements for preventing the starting of machinery while repair men were in dangerous positions have not been adequate, and through oversight of the operators fatal injuries have occurred. Machinists with 17.9 per cent, millwrights with 14.1 per cent, and painters with 12.8 per cent of the fatalities in this department are the largest groups. The nature of danger to the painters is indicated by the fact that 7 out of 10 deaths were due to falls. The various lofty structures of the steel mill which require painting from time to time render liability to a fall very considerable. Hitherto the precautions taken to safeguard this class of workers have been far from adequate.

In this department the deaths are distributed among the causes as follows: 6.4 per cent due to burns, 24.4 per cent to crushing injury, 6.4 per cent to falling objects, 23.1 per cent to falls, 9 per cent to asphyxia, and 29.5 per cent to unclassified injuries.

YARDS.

The internal transportation problem of the steel mills is one of extreme difficulty. Many of the mills have expanded rapidly in confined areas, the resulting congestion bringing about a condition of great hazard. After the presentation of the facts regarding fatal accidents, further comment will be offered on this point. In the two years under consideration there were 109 fatal cases in yard operation.

FATAL ACCIDENTS IN YARD OPERATIONS, BY OCCUPATIONS AND CAUSES, TWO YEARS ENDING JUNE 30, 1910.

Occupations.	Burns from hot metal.	Burns from steam and water.	Burns not specified.	Crushing injury.	Falling objects.	Flying objects.	Falls of worker.	Belts, gears, etc.	Asphyxia.	Unclassified.	Not reported.	Total.	
												Number.	Per cent in each occupation.
Crane hookers	.....	.....	.....	.....	1	2	.....	.....	.....	.....	.....	3	2.8
Cranemen	.....	.....	.....	1	1	.....	1	.....	.....	.....	.....	3	2.8
Cranemen, locomotive	.....	.....	.....	4	.....	.....	.....	.....	.....	1	.....	5	4.6
Drop men	.....	.....	.....	.....	.....	3	.....	.....	.....	.....	.....	3	2.8
Engineers, locomotive	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1	0.9
Firemen, locomotive	.....	2	.....	1	.....	.....	.....	.....	.....	1	.....	4	3.7
Foremen	.....	.....	.....	1	.....	.....	.....	.....	.....	2	.....	3	2.8
Laborers	.....	.....	.....	17	4	.....	4	.....	1	9	.....	35	32.1
Switchmen	1	.....	.....	32	1	2	.....	.....	.....	10	.....	46	42.2
Teamsters	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	1	3	2.8
Unclassified	.....	.....	.....	2	.....	.....	.....	.....	.....	1	.....	3	2.8
Total	1	2	.....	58	7	7	5	.....	1	27	1	109	100.0
Per cent from each cause	0.9	1.8	.....	53.2	6.4	6.4	4.6	.....	0.9	24.8	0.9	100.0	.....

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The cases above shown centered largely in the movement of the trains by which material is shifted from one point to another. Five locomotive cranemen, 1 locomotive engineer, 4 locomotive firemen, and 46 switchmen were killed. These deaths constituted 51.4 per cent of all occurring in the department. Common laborers suffered 32.1 per cent of all fatalities. The hazard to these workers arises from the moving trains and probably still more in the handling of heavy materials. It is impossible to determine the exact relation of these fatalities to the transportation of material by the overhead cranes. Since 17 out of the 35 fatal accidents to laborers were due to crushing injury, it is a fair inference that the material being handled by the cranes was an important cause.[1]

No other occupation group in any department has shown so large a number of fatalities as the group of switchmen. In the mills these are known by several other names—conductors and brakemen most frequently. Since, however, their duties are most clearly defined by the name "switchmen" all these occupations are here combined under this designation. Their duties are somewhat different from those of the railroad occupation having the same name. For the transport of nearly all materials from point to point in the mill yard narrow-gauge trains are used, and these are frequently pushed ahead of the locomotive. The switchman either rides at the head of the train or walks in advance of it, throwing switches as occasion demands and controlling the action of the engineer by his signals. The locomotives are all equipped with air brakes and the control of the train in this particular lies entirely with the engineer. These small trains are not often broken up, so that the dangerous process of coupling does not occur very frequently. When it is necessary it is a part of the switchman's duty to make the coupling. Twenty-seven fatalities occurred among switchmen in 1910, who numbered 990 300-day workers in the establishments reporting. This gives a rate of 27.3 per 1,000 for this occupation.

In view of this extraordinary high fatality rate it is appropriate at this point to consider somewhat in detail the causes contributing to it and to inquire whether this relatively high rate is an unavoidable condition of this employment. A few examples will serve to illustrate the situation. It has been some years since practically all hand coupling of railway cars was abandoned. While the type of coupling in use on the railways is in successful operation in a large number of steel plants on the cars used in the transporting of hot metal there are still managers who insist that it is not applicable to their conditions.

For the smaller ingot cars, charging cars, etc., there is some justification for the claim that automatic coupling is extremely difficult. Two points have been made against the use of these devices. First, that

[1] For further discussion of crane manipulation, see pp. 192, 193, 235, and 236.

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with the sharp curves incident to the narrow-gauge system they would give trouble under certain conditions. Second, that in the ingot trains the hot metal flies out of the molds from time to time, and, falling upon the cars, would effectually interfere with the operation of the coupling device. The adequate reply to this claim is that such devices are in entirely satisfactory use in a large number of steel plants, that the objections to them have all proved unfounded, and that where in use they have practically eliminated coupling accidents.

The condition of steel mill transportation in these particulars is not due to the difficulties of the situation so much as to inertia and a very short-sighted economy. No plant has introduced satisfactory methods without finding that the increased efficiency of operation fully justified the outlay.

The whole transportation problem only requires the application to it of the same degree of energy and engineering skill which have been applied to other departments of the steel mill in order that the present bad preeminence of this department may largely disappear.

The general accident rates (both fatal and nonfatal) for yards are not as high as those for other departments. The high fatality rate noted above for switchmen has led to the conclusion that the greatest dangers of the steel mills are connected with the operation of means of transportation, including especially cars and cranes. This conclusion is not justified when the general accident rate (both fatal and nonfatal) in yards is considered, but it is proper to call special attention to this department. In Chapter IV, on safeguarding, the means and methods of bringing about a change are partially indicated. The suggestions there offered do not, however, go to the root of the matter, the fact being that in many particulars the yard department, in spite of its great importance to the efficiency of the mill, is almost criminally neglected.

The injuries in this department are distributed as follows: Burns, 2.7 per cent; crushing injuries, 53.2 per cent; falling objects, 6.4 per cent; flying objects, 6.4 per cent; falls, 4.6 per cent; unclassed injuries, 24.8 per cent.

One of these groups, that of flying objects, deserves comment. Five of the 7 deaths which occurred from this cause were due to the apparatus called a "drop" or a "skull cracker." Within the ladles for the transport of hot metal a layer of congealed metal gradually accumulates. When this has reached a certain thickness it is pried out and returned to the melting process. These masses called "skulls" are of a size and shape which interferes with handling them. They are accordingly broken up by means of a weight or ball weighing sometimes several tons. This is elevated by a special crane, and when at a certain height is released either by ropes acting upon a trigger, or, if the lifting is done by a magnet, by turning off the current. It is obvious that when this weight strikes the "skull" and breaks it in pieces flying masses of considerable size are sure to be thrown off.

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In view of the very small number of drop men employed it is quite possible that under old conditions, which failed to provide adequate shelter, their death rate may have been even higher than that of the switchmen. In the years under consideration 2 of the 7 deaths were of switchmen whose duties took them in the vicinity of the drop. The dangerous condition in this particular has been very generally remedied.

MISCELLANEOUS DEPARTMENTS.

No one of the departments embraced in this group is sufficiently important from the fatality standpoint to merit a separate consideration. Comment has before been made upon the fact that electrical workers do not suffer fatal injury as frequently from the electric current as they are commonly supposed to do. It is proper to add to the comment already made that electrical workers are frequently required to do their work at an elevation above the ground. This puts them in a position where, like painters and others who have to work under such circumstances, they are liable to injury by falls. It appears in this table that several accidents of this character happened to this group of workers, a greater number, in fact, than arose from electrical shock.

FATAL ACCIDENTS IN MISCELLANEOUS DEPARTMENTS,[1] BY OCCUPATIONS AND CAUSES, TWO YEARS ENDING JUNE 30, 1910.

Occupations.	Burns from hot metal.	Burns from steam and water.	Burns not specified.	Crushing injury.	Falling objects.	Flying objects.	Fall of worker.	Belts, gears, etc.	Asphyxia.	Unclassified.	Not reported.	Total. Number.	Total. Per cent in each occupation.
Boiler cleaners	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1	1.1
Chippers	.....	.....	.....	1	2	.....	.....	.....	.....	.....	2	5	5.3
Core makers	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1	1.1
Crane hookers	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1	1.1
Cranemen	.....	.....	.....	1	.....	.....	1	.....	.....	.....	.....	2	2.1
Electricians and helpers	.....	.....	.....	3	.....	.....	1	.....	1	2	.....	7	7.4
Engineers, stationary	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	1	1.1
Foremen	.....	.....	1	.....	1	.....	.....	1	.....	1	.....	4	4.2
Firemen	.....	.....	.....	1	1	.....	.....	.....	.....	.....	.....	2	2.1
Hammermen and helpers	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1	1.1
Laborers	.....	3	.....	10	8	1	4	.....	1	7	1	35	36.8
Linemen	.....	.....	.....	2	.....	.....	2	.....	.....	1	.....	5	5.3
Motor inspectors	.....	.....	.....	2	.....	.....	.....	.....	.....	1	.....	3	3.2
Motor men	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1	1.1
Molders and helpers	1	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	3	3.2
Oilers	.....	.....	.....	2	.....	.....	.....	.....	.....	1	.....	3	3.2
Puddlers	.....	.....	.....	.....	.....	.....	.....	.....	.....	2	.....	2	2.1
Pump men	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1	1.1
Repair men	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1	1.1
Riggers	.....	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1	1.1
Shearmen	.....	.....	.....	.....	.....	.....	.....	1	.....	1	.....	2	2.1
Structural iron-workers	1	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	2	2.1
Watchmen	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1	1.1
Wire drawers	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1	2	2.1
Unclassified	.....	.....	1	.....	1	.....	1	.....	.....	2	3	8	8.4
Total	2	3	3	28	13	1	9	2	2	25	7	95	100.0
Per cent	2.1	3.2	3.2	29.5	13.7	1.1	9.5	2.1	2.1	26.3	7.4	100.0	.....

[1] Including foundries and electrical department.

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In these miscellaneous departments 36.8 per cent of the injuries were to common laborers. No other occupational group has in excess of 8 per cent. The 95 fatalities are distributed among the causes of death, as follows: 8.5 per cent were due to burns; 29.5 per cent to crushing injury; 13.7 per cent to falling objects; 1.1 per cent to flying objects; 9.5 per cent to fall of the worker; 2.1 per cent to belts, gears, etc.; 2.1 per cent to asphyxia; 26.3 per cent to unclassed injuries. In 7.4 per cent of the cases the cause of death was not reported.

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CHAPTER II.

ACCIDENT EXPERIENCE IN A STEEL PLANT WITH A WELL-DEVELOPED SAFETY SYSTEM, 1905 TO 1910.

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ACCIDENT EXPERIENCE IN A STEEL PLANT WITH A WELL-DEVELOPED SAFETY SYSTEM, 1905 to 1910.

INTRODUCTION.

In the preceding chapter the condition as to accidents in the iron and steel industry as a whole has been discussed on the basis of such statistical data as were available. For the industry as a whole a statistical survey for any considerable period would have been quite impossible, as records existed in only a few plants covering a series of years. In connection, however, with the data for 1910 it was possible to show the number of accidents in many plants for 1909 also. For a thorough understanding of the accident situation in the industry it is obvious that a study of a period of years is desirable. In the absence of data covering a large number of plants, a careful, intensive study of the experience of a single plant for the six years, 1905 to 1910, was determined upon and the results of this study are given in the present chapter. In this plant organized safety work had been introduced and throughout the period covered accident conditions were steadily improving. It would have been more satisfactory if similar studies could have been made in several other plants upon the basis of complete records. This, however, was not possible, as the time and force were not available for such an undertaking. It should be stated, however, that in connection with the collection of the statistical data for the industry as a whole and in connection with this study of the single large plant the existing conditions, and especially the causes of accidents and the measures which have been instituted for their prevention, were studied in many other plants, and the results of these studies are embodied in this and the succeeding chapters.

It has been the intention throughout the report to emphasize the improved conditions which have been attained in order to ascertain what is a reasonable standard of safety. The undesirable conditions yet remaining in American practice are obvious and have been clearly brought to attention in the preceding chapter. In the present chapter a plant is considered presenting in many particulars a high standard. It should be said, however, at the outset that this condition is not at all an unattainable one for any plant.

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The choice of this plant was based upon the following considerations:

1. The length of its continuous operation.
2. The character of the records.
3. The possibility of easy correlation of accident and hospital records.
4. The scope of the plant's activities.
5. The character of the safety organization.

Regarding the extent to which these considerations applied in this plant, the following statement may be made: (1) Complete records regarding accidents were available for the six years ending December 31, 1910. In some particulars the plant has records extending over a period of 20 years. While other plants have been in operation for as long a period, there are very few that have maintained so complete a continuous record. (2) Where the compilation of the records was necessarily limited by the time available, it was highly desirable that they should be in such form that they could be transcribed rapidly and exactly. The records in this case were of the most complete and exact character. The records of individual cases to the number of 30,000 were inspected by an agent of the Bureau, and those pertaining to disabling accidents and fatalities were isolated, and the important facts found in them were drawn off upon specially prepared cards. These numbered 7,750. (3) The records of a claim department or a safety organization naturally do not include all the items necessary for a satisfactory study of the cases. The medical and surgical side needs attention and scrutiny quite as much as the legal and operative side. The relations of this plant to its hospital service were such that the complete hospital records for all the years to which special attention was given were available in each of the cases included in this study. The hospital records of the nature of the injury, the period of disability, and the necessary surgical treatment were carefully considered. (4) To serve the purpose of the present study, the plant chosen must have as large a number as possible of the characteristic operations belonging to the industry. No one plant embodies them all. There are, however, few plants in the country which present a greater variety of steel-mill operations than are found in the plant under consideration. (5) At an earlier point in the report a statement has been made of the points justifying the classification of a given plant in class A, or one in which the safety system is well developed.[1] This plant possesses in a marked degree all the qualifications specified as justifying such a classification, and on this account is particularly favorable as an illustration of successful safety activity.

[1] See p. 45.

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The following description of the plant chosen for consideration is given in order that its size and the physical conditions under which it is operated may be appreciated. The plant is situated upon an irregularly shaped area on a lake shore. On the landward side is a solidly built-up portion of the city in which it is located, and where most of the employees reside. The plant area is bounded at one extremity by a river, which has been dredged to a sufficient depth so that ore boats from the lake may pass up the river a short distance and into a slip alongside an ore yard. At about the middle of the area there extends directly from the lake another and larger slip in which the ore boats are accommodated. The position of these two means of access from the lake have determined the position of the two groups of blast furnaces, each containing five stacks. In the area between these two blast furnace groups are the Bessemer steel mill, the rail mill, and a machine shop and foundry. Skirting this area is an immense railway yard practically continuous along that entire side of the grounds occupied by the plant. Access to the portion of the grounds lying next to the lake is provided by two viaducts extending over these railroad tracks and by a subway. Separated from the remainder of the plant by this railway yard is a smaller area, in which are included the office, laboratory, an open hearth, a slab mill, two plate mills, and a roundhouse for the narrow-gauge locomotives. Beyond the larger slip is another irregular area, including a large open hearth and two structural mills.

At the time the plant was established upon this area most of the ground was low and swampy. A large part of the plant yard has been built up by the use of blast furnace refuse, and a considerable section of the adjacent city has been similarly lifted out of the water. The extent of the blast-furnace installation mentioned above, since a very considerable portion of its product is further handled in the plant itself, gives some idea of the magnitude of the operations. The force employed in the plant under normal conditions approaches 8,000.

These facts with regard to the size of the plant and the number of its employees are of importance, because in a study of this kind, unless a sufficient volume of data can be secured, the results are constantly being rendered inconclusive by irregularities due to mass accidents. Comment has already been made upon this difficulty in discussing the significance of fatality rates. It applies with almost equal force to the general accident rates whenever the plants under consideration are of small size or whenever analysis of too minute a character is attempted.

It must be borne in mind, therefore, that while for purposes of illustration it is necessary in the following discussion to deal with

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some comparatively small groups, their showing must not be understood to be authoritative and conclusive. The only possible means of eliminating the effect of special and unusual occurrences is to treat such volumes of data that their effects, now in one direction and now in the other, will be neutralized and the underlying law of accident occurrence will become evident.

CHARACTER OF WORKING FORCE.

The 8,000 men normally employed in this plant are, like those of most industrial establishments of large size, of a very mixed character. The safety rules have been issued by the company in six languages in order to meet the needs of different groups of the employees.

The following table shows the number and the per cent of employees of each nationality in the plant investigated for each calendar year from 1906 to 1910:

RACE OF EMPLOYEES IN THE LARGE PLANT INVESTIGATED, BY YEARS, 1906 TO 1910.

NUMBER OF EMPLOYEES.

Race.	1906	1907	1908	1909	1910	Total.
American	1,531	1,843	1,645	2,089	2,019	9,127
Croatian	550	235	241	498	343	1,867
German	457	414	303	368	313	1,855
Hungarian	447	356	146	307	294	1,550
Irish	245	216	206	216	285	1,168
Lithuanian	60	114	72	133	72	451
Polish	3,183	3,202	2,397	3,647	3,546	15,975
Scandinavian	573	515	460	496	426	2,470
Slavic	285	163	161	381	273	1,263
Other races	1,037	1,078	699	793	793	4,400
Total	8,368	8,136	6,330	8,928	8,364	40,126

PER CENT OF EACH RACE.

American	18.3	22.7	26.0	23.4	24.1	22.7
Croatian	6.6	2.9	3.8	5.6	4.1	4.7
German	5.5	5.1	4.8	4.1	3.7	4.6
Hungarian	5.3	4.4	2.3	3.4	3.5	3.9
Irish	2.9	2.7	3.3	2.4	3.4	2.9
Lithuanian	.7	1.4	1.1	1.5	.9	1.1
Polish	38.0	39.4	37.9	40.8	42.4	39.8
Scandinavian	6.8	6.3	7.3	5.5	5.1	6.2
Slavic	3.4	2.0	2.5	4.3	3.3	3.1
Other races	12.4	13.2	11.0	8.9	9.5	11.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

The Poles are the most numerous of any single race. In the five years for which data are reported they exceed each of the other races in each year, the percentage being—1906, 38 per cent; 1907, 39.4 per cent; 1908, 37.9 per cent; 1909, 40.8 per cent; 1910, 42.4 per cent. For the entire period they constituted 39.8 per cent of the working force. Next to them come the Americans. This group consists both of those who are American born of foreign fathers and American born of native fathers in about equal proportions. This

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so-called American group is largely of foreign antecedents at no great distance in the past. The percentages of Americans in the different years are: 1906, 18.3 per cent; 1907, 22.7 per cent; 1908, 26 per cent; 1909, 23.4 per cent; 1910, 24.1 per cent; or 22.7 per cent of the entire force for the period of 5 years.

The group consisting of Croatians, Hungarians, and Slavs is next in number to the Americans. The Germans, Irish, and Scandinavians are present in small numbers. The number designated as "Other races" consists of diversified elements.

In the matter of age this working force is comparatively youthful. While the number under 20 years of age is not very considerable, the age group 20 to 29 includes almost 50 per cent of all the employees. There are two reasons for this. First, the work is of a character demanding very largely the strength and vigor of young men. In the second place, the available supply of labor has greatly favored an increase in this age group. The foreign immigration from southeastern Europe has been very largely of single men of this age. Both the nature of the demand and the nature of the supply work together to bring about this preponderance of men in the industry between the ages of 20 and 29. It is not a condition peculiar to this plant; as shown by the immigration figures it prevails throughout the steel industry of the country.

The accompanying table and diagram present graphically certain facts with regard to the character and fluctuations of the working force. The natural division of the force of the steel plant is into productive and nonproductive occupations. While the terms are self-explanatory, a little elaboration is desirable. The productive occupations are those concerned with the handling of the raw material on its way to the processes, with the manipulation of the material during the process, and with the care of the material immediately after the completion of the process. In a rolling mill, for example, they include heaters and their helpers who attend the heating furnaces, the rolling crew who operate the rolls, the shearmen or sawmen and their helpers, and the hotbed men who care for the material after it has passed the rolls. The nonproductive occupations include the mechanics who repair and rebuild the machines, the yard force who attend to the moving and shipping of finished products, and the miscellaneous force of watchmen, caretakers, etc., necessary in the operation of a great plant. The facts are presented with regard to the distribution of these elements of the working force in each of six years. Each year is shown at two periods, the month of smallest working force and that of greatest.

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DISTRIBUTION OF PRODUCTIVE AND NONPRODUCTIVE FORCE IN THE STEEL PLANT INVESTIGATED, AT MONTH OF SMALLEST AND OF LARGEST FORCE IN EACH YEAR, 1905 TO 1910.

NUMBER OF EMPLOYEES.

Groups of occupations.	1905		1906		1907		1908		1909		1910	
	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.
Productive	2,804	3,391	4,506	4,591	3,881	4,932	2,699	3,324	3,142	5,144	4,514	5,767
Nonproductive:												
Mechanical	1,058	1,592	1,144	1,089	1,015	1,431	612	1,035	750	1,014	752	1,254
Yards	1,058	1,453	930	1,322	537	875	286	545	282	507	439	584
Miscellaneous	370	484	572	779	537	716	491	545	515	580	564	752
Total	5,290	6,920	7,152	7,781	5,970	7,954	4,088	5,449	4,689	7,245	6,269	8,357

PER CENT IN SPECIFIED GROUPS OF OCCUPATIONS.

Productive	53	49	63	59	65	62	66	61	67	71	72	69
Nonproductive:												
Mechanical	20	23	16	14	17	18	15	19	16	14	12	15
Yards	20	21	13	17	9	11	7	10	6	7	7	7
Miscellaneous	7	7	8	10	9	9	12	10	11	8	9	9
Total	100	100	100	100	100	100	100	100	100	100	100	100

The table and diagram show that almost continuously through the period the productive force has increased relatively to the nonproductive. The explanation of this increase is to be found in two directions: (1) The use of improved machinery which works more smoothly and requires fewer repairs, and (2) the introduction of mechanical methods of handling the product so that the yard force necessary to care for it has been materially reduced. This progressive reduction of the proportion of mechanics and yard force appears clearly in the diagram on page 111.

Another point brought out is that the fluctuations in the force are more pronounced in the nonproductive group. It rises more rapidly when work is pressing and falls more promptly in times of depression. This is due to the fact that the productive force being less easily recruited is held over times of depression, while the nonproductive is apt to be shifted to suit the demands of the business.

The year 1908 is an exception to the rule, as will appear in all the discussions in which that year is included. It was a year of great and unusual depression. In no other year in the past 10 years was so small a number of workmen employed in the iron and steel industry. The disturbance due to this year is not distinctly shown in the portion of the diagram pertaining to that year. It seems to be like the others. The year 1909 is different. The low month of that year immediately follows the high month of 1908. It was a period of sudden revival of demand for iron and steel products. This revival was not fully anticipated, and as a result large numbers of mechanics were employed in repairs and

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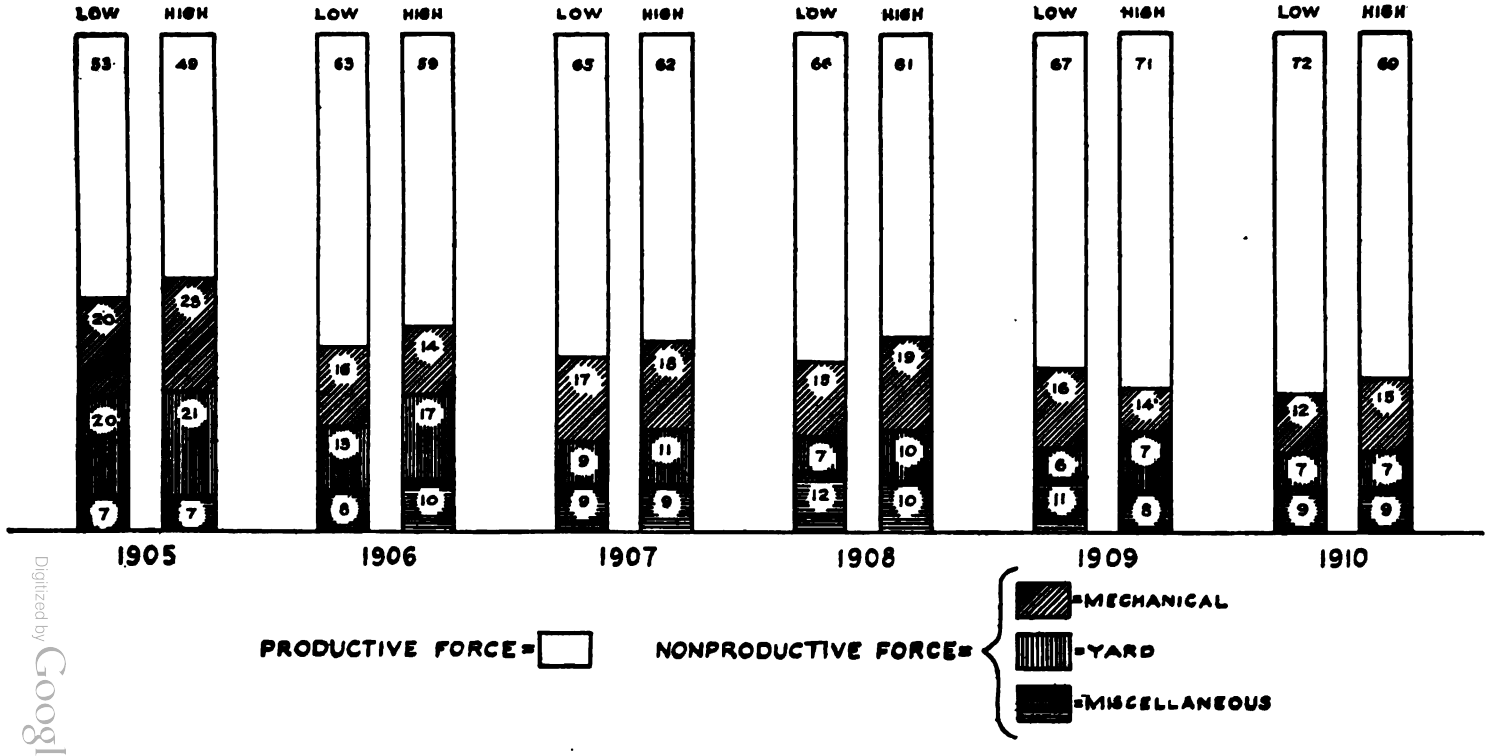
PER CENT OF PRODUCTIVE AND NONPRODUCTIVE FORCE IN A LARGE STEEL PLANT AT MONTH OF SMALLEST AND OF LARGEST FORCE, BY YEARS, 1905 TO 1910.



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renewals which had not been undertaken during the depression. As a result the nonproductive element was more prominent in the low month of 1909 than in the high month. The result is seen in 1909, but the cause must be found in the depression of the preceding year.

The importance to the accident problem of the fluctuation brought out above lies in the fact that the previous discussion has shown that the productive occupations such as those in blast furnaces and steel works are on the whole more dangerous than the nonproductive, such as those in the yards and the mechanical department. The tendency here shown to increase the productive element must increase the hazards unless counteracted. Two things have held in check this tendency to increased accident rates: (1) Production has become more mechanical; (2) constructive effort toward safety has been in progress.

WORKING CONDITIONS.

As has already been explained, the original conditions of the site on which this plant was established were not very satisfactory. Nearly the entire area was swampy and some of it continually submerged. This condition has been remedied, and in the matter of sufficient room for carrying on its various operations the plant is as well circumstanced as any in the country. Some of the buildings are old and would be constructed on better lines if they were to be rebuilt. In some material particulars, however, the plant has undergone a complete reconstruction within recent years, and the new buildings are well equipped and modern in design. While it is not the purpose to discuss in this chapter the subject of safeguarding methods, it is proper to say that in this plant they have been carried out with the utmost thoroughness and that no material matter presented in the chapter on safeguarding fails to be illustrated. It may therefore be said that so far as working conditions are concerned this plant is among the best. Very recently a thorough overhauling of the provisions for water supply and sanitary conveniences has been completed, and in this particular the plant now ranks with others which somewhat earlier completed similar improvements. The hospital used by the plant is immediately at one entrance, and it is possible to utilize this hospital both for the severe and the minor cases of accident.

HOUSING.

As has been pointed out, the plant lies between the lake shore and the built-up portion of the city in which it is located. This portion of the city has been greatly improved since the plant was located there. The swamp lands have been largely filled in with refuse from

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the blast furnaces; many of the streets have been paved and an adequate number of houses for the workpeople have been erected; the water supply and sewerage of the district are fairly adequate, and the houses occupied are on the whole comfortable. There exists here as in other similar towns a considerable amount of overcrowding, due to the custom of the workpeople filling up their houses to the limit with lodgers and boarders. The area in which the workpeople live is well supplied with schools, and excellent social work is going on. While on the whole there are many conditions capable of improvement, it is probable that this body of steel workers are as well situated as any similar body in the country. All these items of favorable conditions in the works and in the homes of the workpeople are of importance as regards the success of the efforts of the company to safeguard its employees.

THE SAFETY ORGANIZATION.

The plant under consideration is one belonging to a group of plants operated by a single company. The interplant safety organization maintained by this company is described in chapter III, on the safety department.[1] The plant organization consists first of the plant safety committee. This committee is under the chairmanship of the assistant general superintendent and includes the director of safety and one of the mill superintendents. This third member of the committee is changed from time to time, so that alternately each mill is brought into relation with the general safety scheme. The safety office under the control of the director of safety, who ranks in the plant organization with the mill superintendents, has an inspection division and a division of claims. The inspection division includes an assistant to the director and two inspectors, one for the day turn and one for the night turn. The assistant is in control of the inspection in the absence of the director, and it is part of his duty to make a regular inspection tour by which he covers the plant about once in two weeks. The two inspectors are particularly occupied with the accidents which occur during their period on duty. The safety office is notified immediately upon the occurrence of an accident, and if the accident is at all serious one of the inspectors, in company with the departmental committee, proceeds immediately to investigate its causes and devise means for its prevention whenever prevention is deemed possible.

The division of claims is also under control of the director of safety. The chief of this division is a lawyer who carries on the necessary investigation from the legal standpoint. Under his direction is an

[1] See pp. 182 and 183.

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investigator who devotes his attention almost exclusively to features of the accidents which are legally important. An office clerk who records the incoming reports of accidents, a stenographer, and an interpreter complete the staff of the safety office. The office is located very near the hospital, and there is constant interchange of information between the two.

Besides the safety office there exist in each of the important departments departmental committees called permanent committees. These are made up of foremen, and it is their duty to make a complete inspection of the department to which they belong once each month. During this inspection they give attention to the following particulars: First, the extent to which their recommendations of the previous month have been carried out; second, additional precautions which they deem necessary either through changes in condition or which have been overlooked previously. A recent development of the departmental committee is the following: A geographical division of the department is made and each member of the committee is made specifically responsible for the condition of an area. He is expected to keep informed of all changes suggested for the area by whomsoever proposed. If they are not promptly carried out it becomes his duty to report and so to hasten action. When the plant inspectors make their regular inspection the condition of these small districts is considered and the man in charge held to account. He becomes a special safety officer for his district. This method has been an outgrowth of the conditions existing in the early months of 1912. During that period there was a very great increase in activity, with the necessity of putting all the men possible to secure at work. This new development of the committee system is one of the efforts being made to keep down the accident rate which always tends to rise at a time of unusual industrial activity.

In addition to these committees this plant was among the first to experiment with committees consisting of ordinary workmen. The personnel of these workmen's committees is changed frequently. While some suggestions of considerable value have come from them, it is evident that their greatest importance lies in familiarizing the rank and file of the working force with the ideas and purposes of the safety organization.

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ACCIDENTS IN OCCUPATIONAL GROUPS.

ACCIDENT RATES FOR THE PLANT AS A WHOLE, 1900 to 1911.

In the following table are presented the general results of safety effort in this plant for a period of 12 years:

DISABLING AND NONDISABLING INJURIES IN PLANT INVESTIGATED AND RATES OF DISABLING INJURIES PER 1,000 300-DAY WORKERS, BY YEARS, 1900 TO 1911.

Years.	300-day workers.	Nondisabling injuries.	Disabling injuries (fatal and nonfatal).	
			Number.	Rate per 1,000, 300-day workers.
1900	5,045	[1] 1,362	1,867	370
1901	5,265	[1] 2,010	1,743	350
1902	5,137	[1] 1,776	1,747	340
1903	5,119	[1] 1,930	1,898	350
1904	5,296	[1] 2,350	1,748	330
1905	6,406	[1] 3,465	1,921	300
1906	7,494	4,926	1,606	214
1907	7,585	5,464	1,434	189
1908	4,575	2,927	685	150
1909	6,215	4,181	1,084	174
1910	7,642	2,791	1,020	133
1911	6,257	2,239	681	109
Total	72,036	35,421	17,434	242

[1] From 1900 to 1905, inclusive, the records of nondisabling injuries are imperfect.

As shown in the above table, it was possible for this period to determine the number of 300-day workers in each year, the number of nondisabling injuries, and the number of disabling injuries. Rates are computed for the disabling injuries, and rates may easily be computed for the nondisabling injuries, but it should be explained that the following facts practically destroy the significance of such rates for the earlier years. Throughout the period the reporting of disabling injuries to the hospital and the safety office has been fairly complete, though it would be too much to say that every disabling accident has been so reported, since unquestionably there are some cases even in as careful a system as that employed in this plant where the disabled man for one reason or another fails to be reported. With regard to the nondisabling injuries, different conditions have prevailed. It will be noticed, for example, that in 1900 the disabling injuries numbered 1,867, while the reported nondisabling injuries were 1,362. In the year 1907 there were 1,434 disabling injuries, while the nondisabling injuries were 5,464. It is probable that the larger number of disabling injuries shown in 1900 were accompanied by as large a proportion of nondisabling accidents as those shown in 1907. The difference between the two years is simply a question of adequate reporting. Beginning with the year 1904, at the instance of the surgeon in charge of the hospital, a more vigorous effort to secure full reports and adequate treatment of the

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injuries not causing disability was made. The results of this special effort are observable in that year and the three following years, there being a steadily increasing number of reports of this sort of injury. In 1908 the depression which affects all the figures for that year is manifest in the decreased number of both kinds of injury. In 1909 they arose again, but in 1910 and 1911 there is a decrease to a point markedly below the numbers shown in 1907. The conditions here exhibited are almost certain to occur in any plant which establishes a thorough-going effort to secure reports of all nondisabling accidents. Unless this matter is pressed with the utmost vigor there will be a great many accidents of this character which will escape record and treatment, and the initial years of the effort to secure their report will appear to be years of great increase in accident occurrence. This apparent increase is, of course, illusory. Since added emphasis upon the care of accidents will almost inevitably react in the direction of preventing them, it is probable that though a larger number of nondisabling accidents is recorded there may be an actual decrease in the number of accidents occurring. That this is true in the case of the plant under consideration is clearly evident in the decreasing rates for disabling accidents during these years when the number recorded of the nondisabling was so markedly increasing. It is also evident from this record of nondisabling accidents that ultimately the efforts for safety influence the occurrence of this kind of accident as well as those of a more serious nature. The later years exhibit a marked decrease in such injuries, the rates per 1,000 300-day workers being as follows: 1907, 720; 1908, 640; 1909, 672; 1910, 365; 1911, 358.

It did not appear in the course of this investigation that a man temporarily absent from work for the purpose of receiving needed surgical attention was ever docked in his pay for the time lost. Accordingly whatever disturbances of a routine of productive activity may result from the temporary absence of a workman falls upon the employer, and from the standpoint of the reduction of these losses he may properly consider the safety effort. There are also among these nondisabling injuries certain possibilities against which an employer may safeguard himself. The reason impelling the chief surgeon of this plant to urge the special effort which was made to secure full reports of nondisabling injuries was principally the fact that cases of severe infection and blood poisoning were frequently coming to the hospital from among those who were slightly injured and who had not been reported and cared for. One very important result of this activity has been to very nearly eliminate cases of infection among those slightly injured. This result reacts favorably both upon the men and upon the employing company. The company which operates a compensation plan, as does the one under consideration, elim-

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inates by close attention to minor injuries many long periods of disability, and since the compensation in no case equals the possible return in wages the man who is spared a case of blood poisoning profits equally with the company in his ability continuously to earn his wage. From all standpoints, therefore, attention to these nondisabling injuries is clearly demanded. In the discussion of hospital and emergency provisions it has been pointed out that much greater care than prevails in many plants must be taken with regard to this class of injury.

Turning now to the rates for disabling injuries disclosed in the table, an interesting history of successful safety effort is presented. Between 1900 and 1911 the effort had been successful to the degree that for every three accidents occurring in 1900 less than one occurred in 1911, the rates being 370 per 1,000 for the former year and 109 per 1,000 for the latter year. The diagram on page 118 presents this change in graphic form. The diagram discloses at once the fact that in the first six years the progress was comparatively slow. Safeguarding methods were being employed and some educational effort carried on. It is with the year 1906, however, that real intensive safety effort became the rule. The rapid decline beginning in that year is convincing evidence of the character of the effort put forth and of the success which attended it.

ACCIDENT RATES, BY DEPARTMENTS, 1905 TO 1910.

In the following table the details of the history of this movement are presented, by departments.

For the 6 years ending December 31, 1910, the individual accident records could be secured and were carefully studied. The records for the period from 1900 to 1910 were on file, but it was not possible to deal with any greater volume than for six years. In these 6 years about 30,000 accidents occurred in the large plant investigated. Among these were 7,750 cases of disabling injury, the remainder belonging to the nondisabling class. The table presents in three sections the number of 300-day workers in each department in each year, the total number of disabling injuries occurring, and the rates per 1,000 300-day workers.

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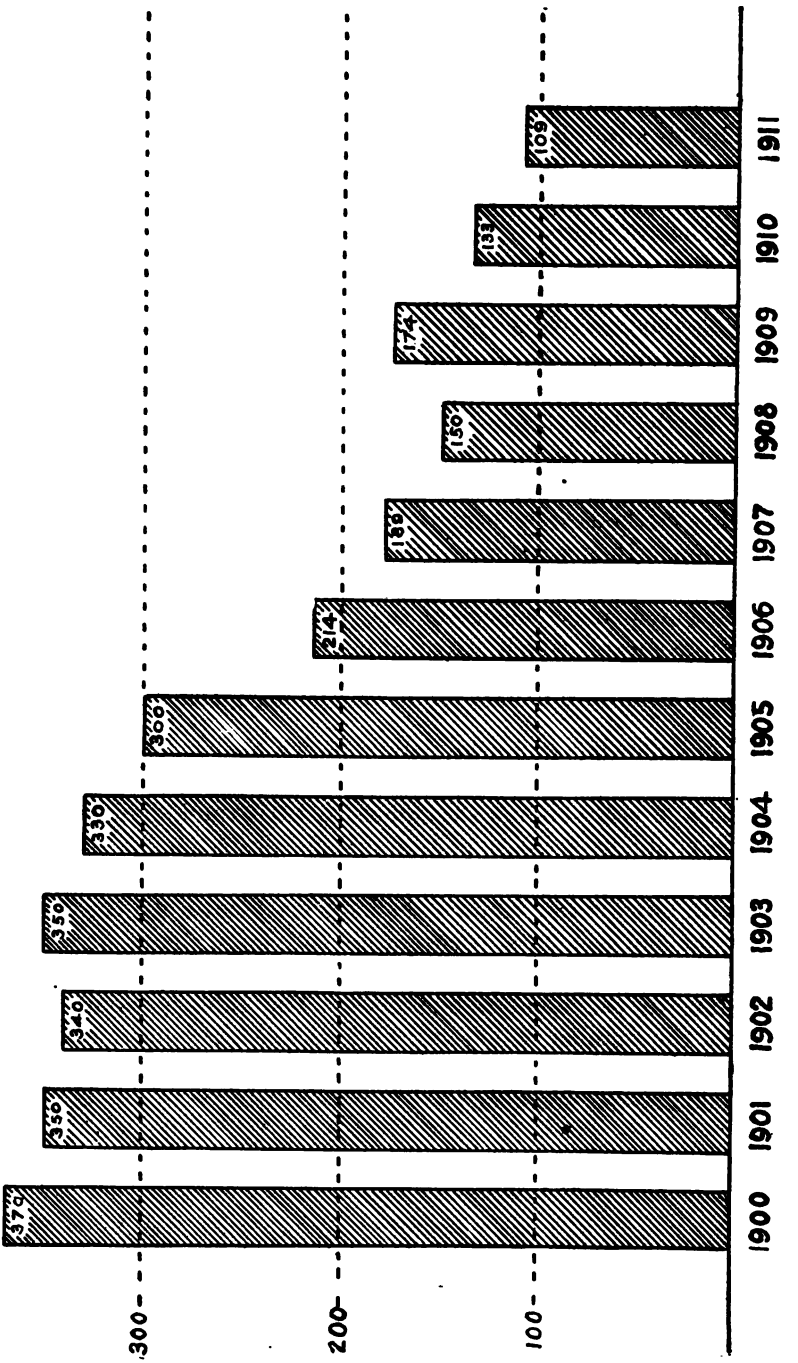
RATES OF DISABLING INJURIES PER 1,000 300-DAY WORKERS IN A LARGE STEEL PLANT, BY YEARS, 1900 TO 1911.



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NUMBER OF 300-DAY WORKERS AND ACCIDENT RATES PER 1,000 IN EACH DEPARTMENT OF PLANT INVESTIGATED, BY YEARS, 1905 TO 1910.

NUMBER OF 300-DAY WORKERS.

Departments.	1905	1906	1907	1908	1909	1910	Total.
Blast furnaces	961	1,262	1,177	993	1,134	1,081	6,608
Bessemer	352	369	385	228	250	346	1,930
Open hearths	388	612	791	276	718	788	3,573
Blooming mills	141	145	225	102	250	270	1,133
Slabbing mills	139	145	170	81	151	178	864
Rail mills	691	717	709	620	736	1,085	4,558
Structural mills	.....	387	371	192	317	393	1,660
Plate mills	425	296	402	133	325	463	2,044
Mechanical	1,088	1,146	1,150	628	713	900	5,625
Foundry	264	336	331	291	453	613	2,288
Docks	289	303	155	76	75	93	991
Yards	1,185	1,136	983	355	402	575	4,586
Electrical	84	104	150	127	149	161	775
Miscellaneous	399	536	636	473	542	696	3,282
Total	6,406	7,494	7,585	4,575	6,215	7,642	39,917

NUMBER OF DISABLING ACCIDENTS.

[This table includes both fatal and nonfatal accidents.]

Blast furnaces	411	418	322	194	220	184	1,749
Bessemer	146	124	128	46	52	74	570
Open hearths	123	155	211	75	174	146	884
Blooming mills	38	25	40	10	29	30	172
Slabbing mills	16	28	37	14	36	19	150
Rail mills	137	112	109	99	139	146	742
Structural mills	11	136	112	23	48	62	392
Plate mills	147	105	66	25	60	39	442
Mechanical	422	187	182	76	78	103	1,048
Foundry	66	47	33	34	121	77	378
Docks	43	29	10	1	7	3	93
Yards	294	202	148	60	94	106	904
Electrical	43	26	25	19	12	13	138
Miscellaneous	24	12	11	9	14	18	88
Total	1,921	1,606	1,434	685	1,084	1,020	7,750

RATES PER 1,000 300-DAY WORKERS.

Blast furnaces	427	331	274	195	194	179	265
Bessemer	415	236	232	202	208	212	295
Open hearths	317	253	267	272	242	185	247
Blooming mills	270	172	178	98	116	111	152
Slabbing mills	115	193	218	173	238	107	174
Rail mills	198	156	154	160	189	135	163
Structural mills	.....	351	302	120	151	158	236
Plate mills	346	354	164	188	185	85	216
Mechanical	388	163	158	121	109	114	186
Foundry	250	140	100	117	267	126	165
Docks	149	96	65	13	93	32	94
Yards	248	179	159	169	234	185	197
Electrical	512	250	167	150	81	81	178
Miscellaneous	60	22	17	19	25	26	27
Total	300	214	189	150	174	133	194

Particular attention is directed to the last section of the above table. In the blast furnaces there is a steady reduction from a rate of 427 per 1,000 in 1905 to 179 per 1,000 in 1910. A part of this reduction, especially that occurring in the earlier years, is undoubtedly due to the substitution of improved construction, but a very large part of it must be attributed to increased attention to details and to a very successful effort to interest the workmen themselves in the idea of reducing the number of accidents. It should also be

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borne in mind that the chief reduction was in injuries involving temporary disability.[1]

In another discussion of the subject it has seemed necessary to combine the two kinds of steel works—Bessemer and open hearth. Their hazards are distinctly different and on that account they are here presented separately, the Bessemer showing a rate of 429 in 1905, and falling to 212 in 1910. The open hearth shows a reduction of from 304 to 185. The combined figures for these two departments place the steel works here as elsewhere in advance of all other departments in their hazard, and the general conclusion that the steel works present the most serious problem is borne out by the history of this plant. The rates are the highest at the outset, and after the reduction which has occurred in the course of the years the rate remains still higher than that of other departments. The greatest decrease among the rolling mills is found in plate mills where there is a drop from 346 to 85. The larger mechanical mills, like blooming, rail, and structural mills, show a definite but less marked reduction. Among the mechanical occupations a condition is found different from that appearing in any other department. The initial rate is 388. In the year 1906 this drops to 163 and then continues to decline, standing at 114 in 1910. The significance of the sudden decline in 1906 in the rate for mechanical occupations will be brought out more properly at a later point where it can be considered in connection with other similar cases. It may be stated that the year 1906 represented a period of thorough reorganization and safeguarding throughout the machine shops and in connection with other mechanical operations and that the accident rate shows a definite response to these efforts.

The most remarkable continuous reduction of rates appears in the electrical department, in which the force consists of a comparatively small body of workmen, and where considerable fluctuations in the accident rate might be expected. The steadiness with which the rate declines from year to year indicates that it is not a spasmodic condition, such as sometimes appears in a small group, but represents a real improvement in conditions and methods. The year 1905 shows a rate of 512, and 1910 a rate of 81, the decline being steady from year to year.

Attention has already been called to the unusual character of the year 1908. In 9 of the departments the rates are higher in the year 1909 than in the year 1908, the rate for the entire plant being 150 in 1908 and 174 in 1909. Inasmuch as this rise in the rate for the whole plant is correlated with a similar change in the majority of the departments, it is evident that it is due to some general cause oper-

[1] See table on p. 123.

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ative throughout. The number of 300-day workers increased from 4,575 to 6,215. This increase affected all the departments with one exception—that is, 1909 was a period of recovery from a severe depression. The demand for the products of the mill increased rapidly, so that instead of gradually increasing the force it rose considerably during the early part of the year. For example, in the last month of 1908 there were 4,800 employees, while by June, 1909, the number had risen to 6,400. From that point throughout the year it continued nearly uniform. In every case of such rapid rise it is inevitable that many of the men taken on will be relatively inexperienced or even entirely new to the work. The result is always a tendency toward a rising accident rate unless some countervailing influence enters.

Another cause was also operative in 1909. Not only were a large number of new men employed in the first six months of the year, but throughout the year, especially in the latter half, the works were driven to their utmost capacity. The combination of a newly recruited force and high intensity of industrial activity is certain to produce increasing numbers of industrial accidents unless there is some counteracting influence. That the rates did not increase beyond those shown in 1907 under these circumstances is evidence of the efficiency of the safety work.

That the increase in accidents was due to the addition of new men to the working force is given additional emphasis when it is observed that the increase in rates is most emphatic in departments in which the employment was largest. For example, in the Bessemer steel works with an increase from 228 to 250 300-day workers, the rates increase from 202 to 208. In the foundry, where the number shifts from 291 to 453, the change in rates is from 117 to 267. In the yard department an increase from 355 to 402 corresponds with increased rates of 169 to 234. It is not to be expected that there will be absolute consistency throughout the departments in a showing of this kind. Other factors, of whose nature and even of whose existence we may be unaware, enter into and complicate the problem. The preceding illustrations are sufficient to show that in general it is a rule that the employment of a new force and the intensification of activity bring about increased hazard. Development of processes and machines nearly always means a lessened hazard. Increased output accompanied by "speeding up" the workmen always increases the danger. The year 1909 was a "speeding up" year. It was also a year of employment of many new workmen. Its accident rate reflects these conditions. The accompanying diagram presents some of these facts graphically.

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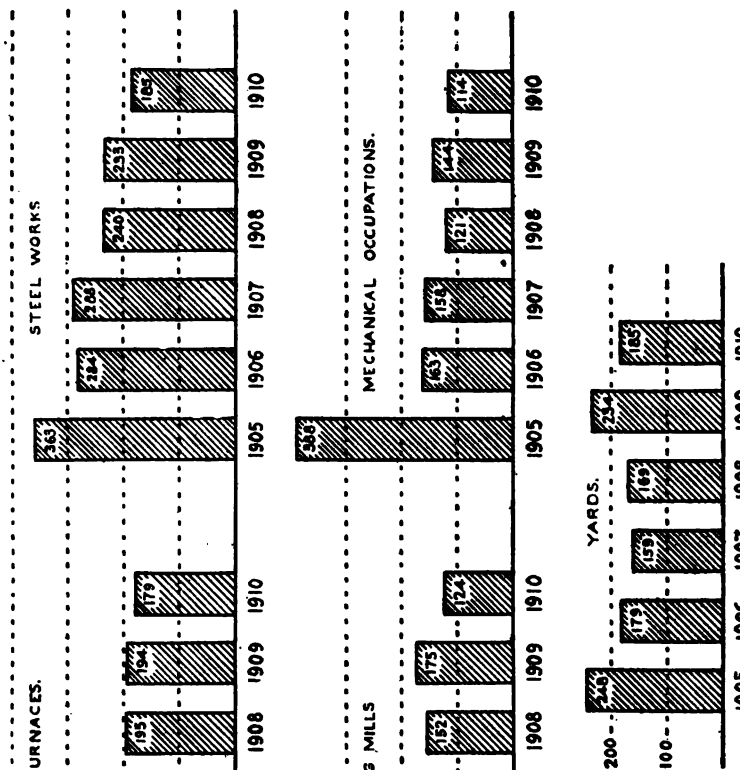
ACCIDENT RATES PER 1,000 300-DAY WORKERS IN PRINCIPAL DEPARTMENTS OF A LARGE STEEL PLANT, BY YEARS, 1905 TO 1910.



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DISABILITY PERIODS.

The following table presents for the entire plant the facts with regard to the disability periods resulting from injuries for the period of six years:

INJURED EMPLOYEES WHO RETURNED TO WORK IN EACH SPECIFIED WEEK, BY YEARS, 1905 TO 1910.

NUMBER OF INJURED EMPLOYEES.

Years.	Total injured employees.	Injured employees who returned to work in each specified week.														
		1st.	2d.	3d.	4th.	5th.	6th.	7th.	8th.	9th.	10th.	11th.	12th.	13th.	14th and later.	Not reported
1905....	1,902	989	336	158	112	91	38	25	22	16	12	4	1	10	19	69
1906....	1,567	572	286	172	104	114	48	29	24	42	11	7	5	13	33	107
1907....	1,409	500	251	167	88	72	58	26	22	27	12	14	9	16	54	93
1908....	673	271	121	65	55	31	25	17	14	10	7	4	4	3	28	18
1909....	1,070	441	167	101	87	54	38	24	24	20	14	2	7	4	26	61
1910....	1,008	382	192	128	89	62	35	13	14	17	7	5	4	5	31	24
Total.	7,629	3,155	1,353	791	535	424	242	134	120	132	63	36	30	51	191	372

PER CENT RETURNING TO WORK IN EACH WEEK.

1905....	100.0	51.9	17.7	8.3	5.9	4.8	2.0	1.3	1.2	0.8	0.6	0.2	0.1	0.5	1.0	3.6
1906....	100.0	36.5	18.3	11.0	6.6	7.3	3.1	1.9	1.5	2.7	.7	.4	.3	.8	2.1	6.8
1907....	100.0	35.5	17.8	11.9	6.2	5.1	4.1	1.8	1.6	1.9	.9	1.0	.6	1.1	3.8	6.6
1908....	100.0	40.3	18.0	9.7	8.2	4.6	3.7	2.5	2.1	1.5	1.0	.6	.6	.4	4.2	2.7
1909....	100.0	41.2	15.6	9.4	8.1	5.0	3.6	2.2	2.2	1.9	1.3	.2	.7	.4	2.4	5.7
1910....	100.0	37.9	19.0	12.7	8.8	6.2	3.5	1.3	1.4	1.7	.7	.5	.4	.5	3.1	2.4
Total.	100.0	41.4	17.7	10.4	7.0	5.6	3.2	1.8	1.6	1.7	.8	.5	.4	.7	2.5	4.9

RATES PER 1,000 300-DAY WORKERS.

1905....	296.9	154.4	52.5	24.7	17.5	14.2	5.9	3.9	3.4	2.5	1.9	0.6	0.2	1.6	3.0	10.8
1906....	209.1	76.3	38.2	23.0	13.9	15.2	6.4	3.9	3.2	5.6	1.5	.9	.7	1.7	4.4	14.3
1907....	185.8	65.9	33.1	22.0	11.6	9.5	7.6	3.4	2.9	3.6	1.6	1.8	1.2	2.1	7.1	12.3
1908....	147.1	59.2	26.4	14.2	12.0	6.8	5.5	3.7	3.1	2.2	1.5	1.1	1.1	.7	6.1	3.9
1909....	172.2	71.0	26.9	16.3	14.0	8.7	6.1	3.9	3.9	3.2	2.3	.3	1.1	.6	4.2	9.8
1910....	131.9	50.0	25.1	16.7	11.6	8.1	4.6	1.7	1.8	2.2	.9	.7	.5	.7	4.1	3.1
Total.	191.1	79.0	33.9	19.8	13.4	10.6	6.1	3.4	3.0	3.3	1.6	.9	.8	1.3	4.8	9.3

The second section of the table shows the percentage of distribution through the successive weeks from the 1st to the 13th, and also those terminating in the 14th and later, and those not reported. These percentages indicate that in an establishment where active safety effort is put forth the first effect is a marked diminution of the accidents causing short periods of disability. For example, those terminating in the first week are 51.9 per cent of all the cases in 1905, while in 1910 they constitute 37.8 per cent. Beyond the sixth week there is naturally great irregularity since the number of cases is relatively small and comparatively slight variations in the number cause a considerable variation in the percentage.

In the third section of the table the rates are presented for each week, and it is possible to see the nature and extent of the changes

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which have occurred from year to year. The first notable feature is that between 1905 and 1906 the rate for disabilities terminating in the first week dropped from 154.4 to 76.3. It will be seen elsewhere that decrease in the short term disabilities was specially marked in the mechanical department and was due to a thorough safeguarding effort at that time.

Comparing the year 1910 with the year 1905 a decrease in the rate is found for nearly every one of the 13 weeks, showing that while the most marked decrease is the one already pointed out in the disabilities terminating in the first week, all classes of injuries from the most minor to the extremely severe have been influenced by the safety movement. This will become even more evident in the following section in which actual losses of time are considered. In Appendixes E and F will be found a detailed presentation of the disability periods, in the first by departments, years, and weeks; in the second by departments, occupations, and weeks.

LOSS OF TIME FROM ACCIDENT.

It is necessary, for a complete understanding of accident data, to consider not only the rates derived from comparing the number of employees with the number of accidents, but also the relation between the number of employees and the amount of time lost. For example, the steel works lead all departments in their accident rate and are also still more in advance when the factor of severity is considered.

The table which follows presents the total days lost and the average per 300-day worker, by departments and by weeks in which the disabilities terminated:

DAYS LOST BY EMPLOYEES WHO RETURNED TO WORK IN EACH SPECIFIED WEEK, BY DEPARTMENTS, FOR THE PERIOD 1905 TO 1910.

NUMBER OF DAYS LOST.

Departments.	Total days lost.	Days lost from disabilities terminating in each specified week.					
		First.	Second.	Third.	Fourth.	Fifth.	Sixth and later.
Blast furnaces	32,467	2,672	3,182	3,258	2,878	3,027	17,450
Bessemer steel works	11,254	751	1,032	1,111	1,176	1,006	6,178
Open-hearth steel works	18,553	1,240	1,705	1,946	2,294	1,453	9,915
Rolling mills	33,941	2,787	3,780	3,344	3,071	3,922	17,037
Mechanical	15,639	1,903	1,906	1,673	1,214	1,029	7,914
Yards	15,217	1,455	1,524	1,517	1,407	1,752	7,562
Foundry	8,698	565	657	617	790	719	5,350
Docks	1,785	95	144	249	278	218	801
Electrical	2,166	254	247	287	130	127	1,121
Miscellaneous occupations	1,559	147	183	210	120	32	867
Total	141,279	11,869	14,360	14,212	13,358	13,285	74,195

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DAYS LOST BY EMPLOYEES WHO RETURNED TO WORK IN EACH SPECIFIED WEEK, BY DEPARTMENTS, FOR THE PERIOD 1905 TO 1910—Concluded.

AVERAGE ANNUAL LOSS IN DAYS PER 300-DAY WORKER.

Departments.	Total days lost.	Days lost from disabilities terminating in each specified week.					
		First.	Second.	Third.	Fourth.	Fifth.	Sixth and later.
Blast furnaces	4.91	0.40	0.48	0.49	0.44	0.46	2.64
Bessemer steel works	5.82	.39	.53	.57	.61	.52	3.20
Open-hearth steel works	5.19	.35	.48	.54	.64	.41	2.77
Rolling mills	3.31	.27	.37	.33	.30	.38	1.66
Mechanical	2.78	.35	.34	.30	.23	.18	1.41
Yards	3.32	.32	.33	.33	.31	.58	1.65
Foundry	3.80	.25	.29	.27	.35	.31	2.34
Docks	1.80	.10	.15	.25	.28	.22	.81
Electrical	[1] 2.79	.33	.32	.37	.17	.16	1.44
Miscellaneous occupations	.48	.04	.05	.06	.04	.01	.26
Total	3.54	.30	.36	.36	.33	.33	1.86

[1] Including case where the injury was followed by infection resulting in disability lasting two years. Omitting this extraordinary case the average loss for the 6 years is 1.85 days.

It has not been thought necessary in this table to extend the consideration to the full number of weeks included in the preceding tables. Since it appeared in these tables that from the sixth week onward there was a considerable degree of irregularity due to the small number of cases, it appeared that a satisfactory presentation would be secured by consolidating those terminating in the sixth week and later, and giving in detail the first five weeks. The number of disabilities terminating before the sixth week in the whole plant was 82 per cent of all temporary disabilities while the time lost was only 47 per cent of total time lost. The first section of the table gives the number of days lost in each of these periods. In the second section of the table the average loss per 300-day worker is determined and this part of the table brings out the relations of real significance.

Considering first the total losses, it is found that they averaged for each 300-day worker 5.82 days in the Bessemer steel works, 5.19 days in the open-hearth steel works, 4.91 in the blast furnace, 3.80 in the foundry, 3.32 in the yards, and 3.31 in the rolling mills. While the rates for the foundry are quite low, the high average loss in days per 300-day worker indicates that the number of severe injuries occurring is very considerable, although not equal to the number in the steel works and the blast furnace. The high proportion of severe injuries in the foundry is further indicated when the losses per 300-day worker for the successive weeks are considered. The losses in the foundry, expressed in fractions of a day per 300-day worker, are as follows: First week, 0.25; second week, 0.29; third week, 0.27; fourth week, 0.35; fifth week, 0.31; while those terminating in the sixth week and later are 2.34 days. The average loss in the sixth week and later is greater than in any of the departments except the

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steel works and the blast furnaces. A similar increase in the loss from week to week is even more strikingly seen in the steel works. The Bessemer has 0.39 of a day in the first week and 0.61 in the fourth, while the open hearth has 0.35 in the first week and 0.64 in the fourth. The mechanical department presents the peculiar situation of having a slightly higher loss from accidents terminating in the first week than in any later week, the figures being, first week, 0.35 of a day; second week, 0.34; third week, 0.30; fourth week, 0.22; fifth week, 0.18. This is in entire consonance with what might be expected from a study of the conditions encountered by the mechanical force.

Considering the plant as a whole, it appears that the weight of loss does not vary greatly through the different weeks, it being 0.30 of a day per 300-day worker in the first, 0.36 in the second and third, and 0.33 in the fourth and fifth.

The effect of considering severity of injury as measured by time lost is brought out conveniently in the following table. The departments are presented in the order of their rates for nonfatal injury. The average losses per 300-day worker are also shown. For convenient comparison the rates and losses are reduced to relative figures by taking the total in each case as 100 and finding the per cents that the items are of these bases. The column showing relative days lost per 300-day worker probably discloses the real position of the several departments more exactly than that showing relative rates.

DEPARTMENTS COMPARED, BY RATES AND AVERAGE YEARLY LOSS PER 300-DAY WORKER, SIX-YEAR PERIOD ENDING DEC. 31, 1910.

Departments.	Rates per 1,000 300-day workers for nonfatal injuries.	Average days lost per 300-day worker.	Relative rates.	Relative days lost per 300-day worker.
Bessemer steel works	288	5.82	137	150
Blast furnaces	258	4.91	123	126
Open hearths	246	5.19	117	133
Yards	195	3.32	93	85
Mechanical	184	2.78	88	71
Rolling mills	183	3.31	87	85
Foundry	164	3.80	78	98
Total	210	3.89	100	100

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The following table presents the average days lost, by years and departments:

AVERAGE DAYS LOST PER 300-DAY WORKER, BY DEPARTMENTS AND BY YEARS, 1905 TO 1910.

AVERAGE NUMBER OF DAYS LOST.

Years.	Blast furnaces.	Bessemer steel works.	Open-hearth steel works.	Rolling mills.	Mechanical.	Foundry.	Docks.	Yards.	Electrical.	Miscellaneous.
1905	5.62	6.12	5.24	3.11	4.75	5.13	2.36	3.26	4.56	0.43
1906	5.42	6.22	6.37	4.52	2.27	3.21	1.65	3.41	2.47	.44
1907	6.90	8.85	5.13	3.83	2.74	3.86	2.32	3.28	2.27	.17
1908	5.19	3.01	4.16	3.24	2.64	2.09	1.00	2.50	[1] 7.09	.79
1909	2.94	4.77	4.99	3.12	2.00	4.92	2.64	4.20	.65	.39
1910	3.35	4.38	4.86	2.37	1.82	3.51	.43	3.23	1.17	.65
Total	4.91	5.82	5.19	3.31	2.78	3.80	1.80	3.32	[1] 2.79	.48

RELATIVE DISTRIBUTION OF AVERAGE DAYS LOST (1905–100).

1905	100	100	100	100	100	100	100	100	100	100
1906	96	102	122	145	48	63	70	105	54	102
1907	123	145	98	123	58	75	98	101	50	40
1908	92	49	79	104	56	41	42	77	155	180
1909	52	78	95	100	42	96	112	129	14	91
1910	60	72	93	75	38	68	18	99	26	151

[1] The year 1908 had in the electrical department one injury followed by blood poison and entailing a disability of 2 years. The average loss for that year, without this extraordinary case, is 1.35 days, and the average loss for the 6 years is 1.85 days.

For purposes of showing more readily the amount of progress which has occurred in each department during the period, the second section of the table is arranged on the plan of considering the losses of 1905 as 100 and reducing those of later years to a proportionate figure. This brings out the fact that the largest decrease in time lost in departments of large size has occurred in the mechanical department, and that this decrease occurred very largely upon the adoption of adequate safeguarding methods, the changes since that time being irregular, although the general tendency is downward. Since each department is placed upon the same basis, the figures of 1910, compared with each other, show the degree in which the several departments have accomplished reductions. The relative figures for 1910 are as follows: Blast furnace, 60; Bessemer, 72; open hearth, 93; rolling mills, 75; mechanical, 38; foundry, 68; docks, 18; yards, 99; electrical department, 26; miscellaneous, 151. In the case of the miscellaneous departments only is a higher figure found in 1910 than in 1905. This is naturally a very erratic group. It falls in one year as low as 40 and rises in another as high as 180. On account of its small size and irregular activities its figures are of no special significance. Elsewhere the condition of yard operations has been discussed and the fact set forth that safeguarding methods in the yards do not appear to have kept pace with those in other depart-

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ments.[1] The figures here given bear out this conclusion. The yard rate declined during the six years from 248 to 185 (p. 119), and it might appear on this basis that very substantial progress had been made, but the days lost per 300-day worker indicate that in spite of a considerable effort the conditions have not been materially changed for the better.[2]

The following table presents the total days lost and the average per 300-day worker for the entire plant, by years:

DAYS LOST FROM DISABILITIES TERMINATING IN EACH SPECIFIED WEEK (BY EMPLOYEES WHO RETURNED TO WORK), BY YEARS, 1905 TO 1910.

TOTAL NUMBER OF DAYS LOST.

Years.	Total days lost.	Days lost from disabilities terminating in each specified week.					
		First.	Second.	Third.	Fourth.	Fifth.	Sixth and later.
1905	25,556	3,301	3,523	2,789	2,799	2,842	10,302
1906	29,217	2,194	3,037	3,093	2,589	3,596	14,708
1907	31,074	1,974	2,724	3,046	2,236	2,271	18,823
1908	15,091	1,183	1,286	1,168	1,355	894	9,205
1909	19,505	1,707	1,754	1,858	2,148	1,717	10,321
1910	20,836	1,510	2,036	2,258	2,231	1,965	10,836
Total	141,279	11,869	14,360	14,212	13,358	13,285	74,195

AVERAGE DAYS LOST PER 300-DAY WORKER.

1905	3.99	0.52	0.55	0.44	0.44	0.44	1.61
1906	3.90	.29	.41	.41	.35	.48	1.96
1907	4.10	.26	.36	.40	.29	.30	2.48
1908	3.30	.25	.28	.25	.30	.20	2.01
1909	3.14	.27	.28	.30	.35	.28	1.66
1910	2.73	.20	.27	.30	.29	.26	1.42
Total	3.54	.30	.36	.36	.33	.33	1.86

The accompanying diagram brings out clearly some features which are exhibited by the table. The purpose of this diagram was to project an easily understood picture of the relationship between the less severe and the more severe accidents and the safety effort which has been in progress. The year 1905 is taken as 100. The losses from accidents terminating in the first week are represented by the shaded areas superimposed upon areas representing losses from the accidents terminating in the sixth week and later. The numbers shown in the diagram are the per cents which the average loss in each case is of the average for 1905. During this period of special activity in safety work there has been a considerable diminution of the accidents terminating in the first week. In the first three years, however, while this result was being accomplished, the losses from accidents terminating in the sixth week and later were steadily and considerably increasing. The conditions

[1] See p. 100. [2] See p. 127.

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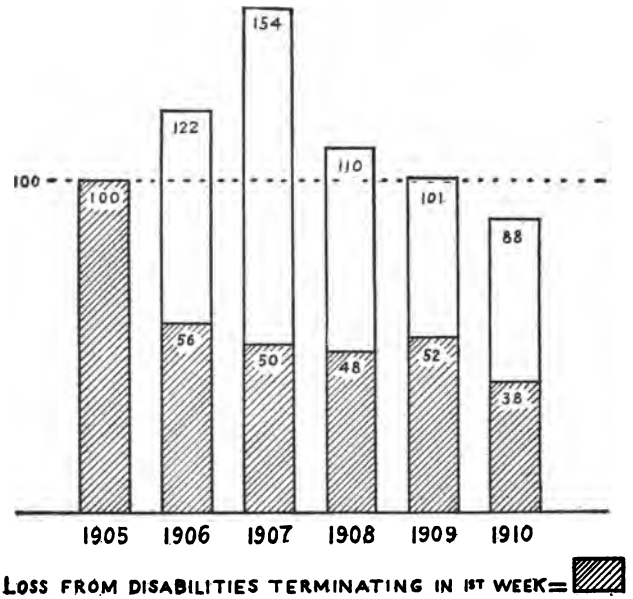
obtaining in these three years fully explain this increase in more severe accidents. The years 1906 and 1907 were years of extraordinary and increasing activity, and with this extra pressure upon the working force the losses from minor accidents were cut down, while those from more severe accidents increased. It should be noted again that this increase might not be apparent, in fact is not apparent, from the study of rates alone. It is only when to the

PER CENT WHICH AVERAGE DAYS LOST PER 300-DAY WORKER FROM DISABILITIES TERMINATING IN FIRST AND IN SIXTH WEEK AND LATER IN EACH YEAR IS OF AVERAGE DAYS LOST IN CORRESPONDING WEEKS IN 1905.

[Average days lost in 1905=100 for each class of disabilities.]



study of rates is added a study of this factor of severity, the only clew to which is the length of disability, that the true state of the case appears. Apparently, with the progress of the safety movement there develops a control as regards severity also. The year 1910 was one of activity quite comparable with the earlier years which have been mentioned, but in spite of that high activity substantial decrease in the losses from severer accidents occurs.

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The following table gives for each year the details with regard to these average losses, department by department:

LOSS OF TIME FROM ACCIDENTS, BY DEPARTMENTS AND YEARS, AND BY WEEKS IN WHICH EMPLOYEES RETURNED TO WORK, 1905 TO 1910.

BLAST FURNACES.

NUMBER OF DAYS LOST.

Years.	Number of 300-day workers.	Total days lost.	Days lost by employees who returned to work in each specified week.					
			First.	Second.	Third.	Fourth.	Fifth.	Sixth and later.
1905	961	5,400	697	729	664	705	720	1,885
1906	1,262	6,834	555	871	838	649	933	2,988
1907	1,177	8,116	389	573	801	431	434	5,488
1908	993	5,156	315	391	274	399	187	3,590
1909	1,134	3,339	431	288	368	298	312	1,642
1910	1,081	3,622	285	330	313	396	441	1,857
Total	6,608	32,467	2,672	3,182	3,258	2,878	3,027	17,450

AVERAGE DAYS LOST PER 300-DAY WORKER.

1905	961	5.62	0.73	0.76	0.69	0.73	0.75	1.96
1906	1,262	5.42	.44	.69	.66	.51	.74	2.37
1907	1,177	6.90	.33	.49	.68	.37	.37	4.66
1908	993	5.19	.32	.39	.28	.40	.19	3.62
1909	1,134	2.94	.38	.25	.32	.26	.28	1.45
1910	1,081	3.35	.26	.31	.29	.37	.41	1.72
Total	6,608	4.91	.40	.48	.49	.44	.46	2.64

BESSEMER STEEL WORKS.

NUMBER OF DAYS LOST.

1905	352	2,155	224	316	317	267	219	812
1906	369	2,296	129	259	234	205	343	1,126
1907	385	3,407	141	211	256	366	253	2,180
1908	228	687	90	98	54	48	64	333
1909	250	1,192	75	49	86	91	66	825
1910	346	1,517	92	99	164	199	61	902
Total	1,930	11,254	751	1,032	1,111	1,176	1,006	6,178

AVERAGE DAYS LOST PER 300-DAY WORKER.

1905	352	6.12	0.64	0.90	0.90	0.76	0.62	2.30
1906	369	6.22	.35	.70	.63	.56	.93	3.05
1907	385	8.85	.37	.55	.66	.95	.66	5.66
1908	228	3.01	.39	.43	.24	.21	.28	1.46
1909	250	4.77	.30	.20	.34	.36	.26	3.30
1910	346	4.38	.26	.29	.47	.57	.18	2.61
Total	1,930	5.82	.39	.53	.57	.61	.52	3.20

OPEN HEARTH STEEL WORKS.

NUMBER OF DAYS LOST.

1905	388	2,032	206	220	153	275	243	935
1906	612	3,900	180	182	403	423	258	2,454
1907	791	4,055	306	450	510	474	343	1,972
1908	276	1,148	127	182	198	220	100	321
1909	718	3,586	199	396	329	495	256	1,911
1910	788	3,832	222	275	353	407	253	2,322
Total	3,573	18,553	1,240	1,705	1,946	2,294	1,453	9,915

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LOSS OF TIME FROM ACCIDENTS, BY DEPARTMENTS AND YEARS, AND BY WEEKS IN WHICH EMPLOYEES RETURNED TO WORK, 1905 TO 1910—Continued.

OPEN HEARTH STEEL WORKS—Concluded.

AVERAGE DAYS LOST PER 300-DAY WORKER.

Years.	Number of 300-day workers.	Total days lost.	Days lost by employees who returned to work in each specified week.					
			First.	Second.	Third.	Fourth.	Fifth.	Sixth and later.
1905	388	5.24	0.53	0.57	0.39	0.71	0.63	2.41
1906	612	6.37	.29	.30	.66	.69	.42	4.01
1907	791	5.13	.39	.57	.64	.60	.43	2.49
1908	276	4.16	.46	.66	.72	.80	.36	1.16
1909	718	4.99	.28	.55	.46	.69	.36	2.66
1910	788	4.86	.28	.35	.45	.52	.32	2.95
Total	3,573	5.19	.35	.48	.54	.64	.41	2.77

ROLLING MILLS.

NUMBER OF DAYS LOST.

1905	1,396	4,348	524	822	514	441	522	1,525
1906	1,690	7,646	591	716	710	621	1,086	3,922
1907	1,877	7,196	490	792	608	325	624	4,267
1908	1,128	3,658	264	296	252	344	279	2,223
1909	1,779	5,545	501	395	541	733	701	2,674
1910	2,389	5,548	417	759	629	607	710	2,426
Total	10,259	33,941	2,787	3,780	3,344	3,071	3,922	17,037

AVERAGE DAYS LOST PER 300-DAY WORKER.

1905	1,396	3.11	0.38	0.59	0.37	0.32	0.37	1.09
1906	1,690	4.52	.35	.42	.42	.37	.64	2.32
1907	1,877	3.83	.26	.42	.37	.17	.33	2.27
1908	1,128	3.24	.23	.26	.22	.30	.25	1.97
1909	1,779	3.12	.28	.22	.30	.41	.39	1.50
1910	2,389	2.32	.17	.32	.26	.25	.30	1.02
Total	10,259	3.31	.27	.37	.33	.30	.38	1.66

MECHANICAL DEPARTMENT.

NUMBER OF DAYS LOST.

1905	1,088	5,166	805	681	573	431	442	2,234
1906	1,146	2,599	343	400	367	156	287	1,046
1907	1,150	3,153	321	351	327	227	101	1,826
1908	628	1,660	136	124	149	95	38	1,118
1909	713	1,423	122	136	55	130	67	913
1910	900	1,638	176	214	202	175	94	777
Total	5,625	15,639	1,903	1,906	1,673	1,214	1,029	7,914

AVERAGE DAYS LOST PER 300-DAY WORKER.

1905	1,088	4.75	0.74	0.63	0.53	0.39	0.41	2.05
1906	1,146	2.27	.30	.35	.32	.14	.25	.91
1907	1,150	2.74	.28	.31	.28	.20	.09	1.59
1908	628	2.64	.22	.20	.24	.15	.06	1.78
1909	713	2.00	.30	.21	.34	.33	.22	1.72
1910	900	1.82	.20	.24	.22	.19	.10	.86
Total	5,625	2.78	.35	.34	.30	.22	.18	1.41

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LOSS OF TIME FROM ACCIDENTS, BY DEPARTMENTS AND YEARS, AND BY WEEKS IN WHICH EMPLOYEES RETURNED TO WORK, 1905 TO 1910—Continued.

FOUNDRY.

NUMBER OF DAYS LOST.

Years.	Number of 300-day workers.	Total days lost.	Days lost by employees who returned to work in each specified week.					
			First.	Second.	Third.	Fourth.	Fifth.	Sixth and later.
1905	264	1,355	110	173	50	103	94	825
1906	336	1,077	58	72	33	101	59	754
1907	331	1,277	32	68	.....	96	93	986
1908	291	611	71	23	68	50	70	329
1909	453	2,227	217	149	241	237	155	1,228
1910	613	2,151	77	172	225	201	248	1,228
Total	2,288	8,698	565	657	617	790	719	5,350

AVERAGE DAYS LOST PER 300-DAY WORKER.

1905	264	5.13	0.42	0.64	0.19	0.39	0.36	3.13
1906	336	3.21	.17	.21	.10	.30	.18	2.24
1907	331	3.86	.10	.21	.....	.30	.28	2.98
1908	291	2.09	.24	.08	.23	.17	.24	1.13
1909	453	4.92	.48	.33	.53	.52	.34	2.71
1910	613	3.51	.13	.28	.37	.33	.40	2.00
Total	2,288	3.80	.25	.29	.27	.35	.31	2.34

DOCKS.

NUMBER OF DAYS LOST.

1905	289	682	51	41	106	150	218	116
1906	303	499	19	54	52	102	.....	272
1907	155	360	14	.....	41	.....	.....	305
1908	76	6	6	.....	.....	.....	.....	.....
1909	75	198	.....	40	50	.....	.....	108
1910	93	40	5	9	.....	26	.....	.....
Total	991	1,785	95	144	249	278	218	801

AVERAGE DAYS LOST PER 300-DAY WORKER.

1905	289	2.36	0.18	0.14	0.37	0.52	0.75	0.40
1906	303	1.65	.06	.18	.17	.34	.....	.90
1907	155	2.32	.09	.....	.26	.....	.....	1.97
1908	76	1.00	1.00	.....	.....	.....	.....	.....
1909	75	2.64	.....	.53	.67	.....	.....	1.44
1910	93	.43	.05	.10	.....	.28	.....	.....
Total	991	1.80	.10	.15	.25	.28	.22	.81

YARD DEPARTMENT.

NUMBER OF DAYS LOST.

1905	1,185	3,862	546	431	338	376	352	1,819
1906	1,136	3,872	257	357	361	285	630	1,982
1907	933	3,062	204	271	253	288	393	1,653
1908	355	889	121	108	155	122	121	262
1909	402	1,687	144	218	152	142	130	901
1910	575	1,845	183	139	258	194	126	945
Total	4,586	15,217	1,455	1,524	1,517	1,407	1,752	7,562

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LOSS OF TIME FROM ACCIDENTS, BY DEPARTMENTS AND YEARS, AND BY WEEKS IN WHICH EMPLOYEES RETURNED TO WORK, 1905 TO 1910—Concluded.

YARD DEPARTMENT—Concluded.

AVERAGE DAYS LOST PER 300-DAY WORKER.

Year.	Number of 300-day workers.	Total days lost.	Days lost by employees who returned to work in each specified week.					
			First.	Second.	Third.	Fourth.	Fifth.	Sixth and later.
1905	1,185	3.26	0.46	0.36	0.29	0.32	0.30	0.54
1906	1,136	3.41	.23	.31	.32	.25	.55	1.74
1907	933	3.28	.22	.29	.27	.31	.42	1.77
1908	355	2.50	.34	.30	.44	.34	.34	.74
1909	402	4.20	.36	.54	.38	.35	.32	2.24
1910	575	3.23	.32	.24	.45	.34	.22	1.65
Total	4,586	3.32	.32	.33	.33	.31	.38	1.65

ELECTRICAL DEPARTMENT.

NUMBER OF DAYS LOST.

1905	84	383	79	74	36	51	32	111
1906	104	257	51	88	57	25	.....	36
1907	150	340	48	8	108	.....	30	146
1908	127	[1] 901	48	16	18	54	35	[1] 730
1909	149	97	10	42	15	.....	30	.....
1910	161	188	18	19	53	.....	.....	98
Total	775	2,166	254	247	287	130	127	1,121

AVERAGE DAYS LOST PER 300-DAY WORKER.

1905	84	4.56	0.94	0.88	0.43	0.61	0.38	1.32
1906	104	2.47	.49	.85	.55	.24	.....	.35
1907	150	2.27	.32	.05	.72	.....	.20	.97
1908	127	[1] 7.09	.38	.13	.14	.43	.28	[1] 5.75
1909	149	.65	.07	.27	.10	.....	.20	.....
1910	161	1.17	.11	.12	.33	.....	.....	.61
Total	775	[1] 2.79	.33	.32	.37	.17	.16	[1] 1.44

MISCELLANEOUS OCCUPATIONS.

NUMBER OF DAYS LOST.

1905	399	173	59	36	38	.....	.....	40
1906	536	237	11	38	38	22	.....	128
1907	636	108	29	.....	52	27	.....	.....
1908	473	375	5	48	.....	23	.....	299
1909	542	211	8	41	21	22	.....	119
1910	696	455	35	20	61	26	32	281
Total	3,282	1,559	147	183	210	120	32	867

AVERAGE DAYS LOST PER 300-DAY WORKER.

1905	399	0.43	0.15	0.09	0.10	.....	.....	0.10
1906	536	.44	.03	.07	.07	0.04	.....	.24
1907	636	.17	.05	.....	.08	.04	.....	.....
1908	473	.79	.01	.10	.....	.05	.....	.63
1909	542	.39	.01	.08	.04	.04	.....	.22
1910	696	.65	.05	.03	.09	.04	0.05	.40
Total	3,282	.48	.04	.05	.06	.04	.01	.26

[1] Including 1 case causing disability of 2 years, not due directly to accident but to infection following the injury. In so small a department this influences the average loss very strongly. Without it the general average for 1908 is 1.35 days, and for the 6 years, 1.85.

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A general view of the changes in time lost on account of accidents from year to year, as given in detail in the preceding table, can be obtained by showing the combined loss in days per 300-day worker from minor disabilities terminating before the sixth week, as compared with the loss from more severe disabilities terminating in the sixth week and later. This is done for the four fundamental departments—blast furnaces, Bessemer steel works, open-hearth steel works, and rolling mills in the table which follows:

TIME LOST PER 300-DAY WORKER FROM DISABILITIES TERMINATING BEFORE THE SIXTH WEEK AND IN THE SIXTH WEEK AND LATER, IN SPECIFIED DEPARTMENTS, 1905 TO 1910.

Years.	Average days lost per 300-day worker from disabilities in—							
	Blast furnaces.		Bessemer steel works.		Open-hearth steel works.		Rolling mills.	
	Terminating before sixth week.	Terminating in sixth week and later.	Terminating before sixth week.	Terminating in sixth week and later.	Terminating before sixth week.	Terminating in sixth week and later.	Terminating before sixth week.	Terminating in sixth week and later.
1905	3.66	1.96	3.82	2.30	2.83	2.41	2.03	1.09
1906	3.04	2.37	3.17	3.05	2.36	4.01	2.20	2.32
1907	2.24	4.66	3.19	5.66	2.63	2.49	1.55	2.27
1908	1.58	3.62	1.55	1.46	3.00	1.16	1.26	1.97
1909	1.49	1.45	1.46	3.30	2.34	2.66	1.60	1.50
1910	1.64	1.72	1.77	2.61	1.92	2.95	1.30	1.02

The above comparison shows that in the four departments presented the less severe accidents have declined quite steadily in the amount of time lost, while the more severe accidents have fluctuated, tending to rise in the first three years and declining later. The table also shows that the average days lost from severe accidents in the steel works remains high in the last two years of the period, as compared with the first year, indicating that in this department a serious problem remains to be solved in reducing the loss from such accidents.

In the mechanical department the reductions are of a decided character. The disabilities terminating in the first week show a relatively greater loss for the period than is shown for those terminating in any one of the four weeks immediately following. In the foundry the average days lost seems to have been rather irregular, possibly due to a greater irregularity of employment. In 1908 the number of employees in the foundry was very small. In 1909 it was rapidly increased, and a considerable increase in average time lost per 300-day worker appears. This is added evidence that inexperienced men are not only liable to a greater number of accidents but to those of a more severe character. That 1909 saw a large increase in the number of employees of this department, many of whom were doubtless more or less inexperienced, is significant.

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The force operating at the docks is so completely changed in the period that no conclusions are properly deducible from the figures presented. In 1905 there were 289 employed; in 1906, 303; in 1909, 75, and in 1910, 93.[1] This great decrease in the number employed coincides with an entire revolution in the matter of handling ore at the docks, so that the figures of the successive years are not perfectly comparable. That the change in the method has been on the whole beneficial to the individual man so far as loss of time is concerned is indicated by the fact that the average loss in 1905 was 2.36 days per man, while in 1910 it was 0.43 of a day. Perhaps even more striking is the difference between the total days lost. The number lost in 1905 was 682, in 1910, 40. The fact has already been pointed out that in the yard department the average losses from year to year do not indicate any great improvement. The minor injuries have changed quite definitely for the better in that for disabilities terminating in the first week 0.46 of a day was lost in 1905 and 0.32 in 1910. On the whole, in the severer injuries the change has been in the direction of increased rather than of decreased losses.

No department shows a more remarkable change for the better than the electrical.[2] As already noted, the hazard connected with the electrical current does not appear to be very serious so far as the general working force is concerned. Attention may be called again to the fact that the kind of accidents which occur to workers in this line give a strong impression of severity and danger, but when these spectacular accidents are presented in the form of rates they are found to be very much less serious than other sources of danger. In the establishment under consideration the improvement in the condition of the electrical workers has been very marked. In 1905 they lost 4.56 days each, while in 1910 they lost 1.17 days. That accidents of a severe character are not especially prevalent in this department is apparent when the time lost from disabilities terminating in the sixth week and later is considered. The miscellaneous occupations, as has already been pointed out, are of such an irregular character that the figures for them have no special significance.

Before leaving the subject of loss of time from accidents it should be stated that since fatalities and permanent injuries have not declined as rapidly as temporary disabilities it is evident that the cost of accidents would not show as rapid a reduction as accident rates. Since the available figures do not give exact information regarding the amount of permanent disablement accompanying the permanent injuries, no estimate of costs is possible.

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[1] See p. 119.

[2] In the tables themselves attention has been called to the intrusion in 1908 of a single unusual case having a disability of two years. In so small a department such a case may entirely obscure the essential relations. Since this long disability was due to causes outside the accident it should be disregarded in estimating the department.

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DIRECT CAUSES OF INJURY.

The data available for the discussion in Chapter I did not furnish a sufficient basis for a study of the causes of injury except in the case of fatalities. It is possible for the large plant under consideration in this chapter to present this matter in some detail. The following table arranges the injuries of the six-year period by departments and by cause of injury. The second section of the table presents the percentages of injuries due to each cause. The third section shows the per cent of injuries happening in each department.

DIRECT CAUSE OF INJURY IN PLANT INVESTIGATED, BY DEPARTMENTS, FOR THE PERIOD OF SIX YEARS, 1905 TO 1910.

NUMBER OF INJURIES.

Causes of injury.	Blast furnaces.	Steel works.	Blooming and slabbing mills.	Rail mill.	Plate mill.	Structural mill.	Foundry.	Yards.	Mechanical and electrical.	Docks.	Miscellaneous.	Total.
Asphyxiating gas	80	10	2	.....	2	.....	.....	3	17	.....	3	117
Burning gas	36	40	4	1	8	.....	7	.....	5	.....	1	102
Exploding gas	20	15	.....	.....	.....	.....	1	6	8	.....	.....	50
Hot-metal explosions and spills	280	302	9	9	8	3	43	13	20	.....	4	691
Furnace breakouts	23	31	.....	.....	.....	.....	1	.....	.....	.....	.....	55
Furnace slips	126	.....	.....	.....	.....	.....	.....	6	9	.....	1	142
Hot water and steam	39	11	4	3	2	.....	4	6	24	.....	1	94
Electricity	12	7	12	6	9	17	6	1	43	5	.....	118
Nails, splinters, etc	29	14	2	5	12	2	4	15	30	1	6	120
Belts, gears, etc	7	2	.....	5	1	8	.....	2	17	.....	1	43
Cranes	28	152	45	54	32	66	106	57	58	22	2	622
Locomotives, cars, etc	27	53	7	9	2	8	3	177	31	7	2	326
Switches	.....	1	.....	.....	.....	.....	.....	16	.....	.....	.....	17
Flying scale	72	40	10	20	9	3	27	29	87	2	3	302
Falling and flying objects	408	358	98	160	160	67	92	287	271	29	22	1,952
Metal in usual motion	2	.....	1	41	21	39	.....	1	2	.....	.....	107
Metal in unusual motion	.....	.....	.....	8	3	4	.....	.....	2	.....	.....	17
Handling stock	123	95	21	29	29	19	18	89	32	1	6	462
Lifting weights	6	17	.....	3	.....	.....	4	9	11	.....	1	51
Handling material in process	4	.....	8	93	56	32	2	9	12	.....	.....	216
Piling, loading, etc.	1	.....	3	77	2	14	.....	11	1	.....	.....	109
Using tools	80	77	25	57	9	26	13	27	92	.....	4	410
Operating machines	69	44	22	55	29	21	8	19	150	8	.....	425
Falls	178	127	37	75	28	45	22	88	177	14	19	810
Yard conditions	16	14	4	6	7	4	3	14	14	.....	2	84
Unclassified	30	27	6	9	3	7	12	16	48	3	9	170
Not reported	53	17	2	17	10	7	2	3	25	1	1	138
Total	1,749	1,454	322	742	442	392	378	904	1,186	93	88	7,750

PER CENT FROM EACH CAUSE.

Asphyxiating gas	4.6	0.7	0.6	.....	0.5	.....	.....	0.3	1.4	.....	3.4	1.5
Burning gas	2.1	2.8	1.2	0.1	1.8	.....	1.9	.....	.4	.....	1.1	1.3
Exploding gas	1.1	1.0	.....	.....	.....	.....	.3	.7	.7	.....	.....	.6
Hot-metal explosions and spills	16.0	20.8	2.8	1.2	1.8	0.8	11.4	1.4	1.7	.....	4.5	8.9
Furnace breakouts	1.3	2.1	.....	.....	.....	.....	.3	.....	.....	.....	.....	.6
Furnace slips	7.2	.....	.....	.....	.....	.....	.....	.7	.8	.....	1.1	1.8
Hot water and steam	2.2	.8	1.2	.4	.5	.....	1.1	.7	2.0	.....	1.1	1.2
Electricity	.7	.5	3.7	.8	2.0	4.3	1.6	.1	3.6	5.4	.....	1.5
Nails, splinters, etc	1.7	1.0	.6	.7	2.7	.5	1.1	1.7	2.5	1.1	6.8	1.5

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DIRECT CAUSE OF INJURY IN PLANT INVESTIGATED, BY DEPARTMENTS, FOR THE PERIOD OF SIX YEARS, 1905 TO 1910—Concluded.

PER CENT FROM EACH CAUSE—Concluded.

Causes of injury.	Blast furnaces.	Steel works.	Blooming and slabbing mills.	Rail mill.	Plate mill.	Structural mill.	Foundry.	Yards.	Mechanical and electrical.	Docks.	Miscellaneous.	Total.
Belts, gears, etc	.4	.1	.....	.7	.2	2.0	.....	.2	1.4	.....	1.1	.6
Cranes	1.6	10.5	14.0	7.3	7.2	16.8	28.0	6.3	4.9	23.7	2.3	8.0
Locomotives, cars, etc	1.5	3.5	2.2	1.2	.5	2.0	.8	19.6	2.6	7.5	2.3	4.2
Switches	.....	.1	.....	.....	.....	.....	.....	1.8	.....	.....	.....	.2
Flying scale	4.1	2.8	3.1	2.7	2.0	.8	7.1	3.2	7.3	2.2	3.4	3.9
Falling and flying objects	23.3	24.6	30.4	21.6	36.2	17.1	24.3	31.7	22.9	31.2	25.0	25.2
Metal in usual motion	.1	.....	.3	5.5	4.8	9.9	.....	.1	.2	.....	.....	1.4
Metal in unusual motion	.....	.....	.....	1.1	.7	1.0	.....	.....	.2	.....	.....	.2
Handling stock	7.0	6.5	6.5	3.9	6.6	4.8	4.8	9.8	2.7	1.1	6.8	6.0
Lifting weights	.3	1.2	.....	.4	.....	.....	1.1	1.0	.9	.....	1.1	.7
Handling material in process	.2	.....	2.5	12.5	12.7	8.2	.5	1.0	1.0	.....	.....	2.8
Piling, loading, etc.	.1	.....	.9	10.4	.5	3.6	.....	1.2	.1	.....	.....	1.4
Using tools	4.6	5.3	7.8	7.7	2.0	6.6	3.4	3.0	7.8	.....	4.5	5.3
Operating machines	3.9	3.0	6.8	7.4	6.6	5.4	2.1	2.1	12.6	8.6	.....	5.5
Falls	10.2	8.7	11.5	10.1	6.3	11.5	5.8	9.7	14.9	15.1	21.6	10.5
Yard conditions	.9	1.0	1.2	.8	1.6	1.0	.8	1.5	1.2	.....	2.3	1.1
Unclassified	1.7	1.9	1.9	1.2	.7	1.8	3.2	1.8	4.0	3.2	10.2	2.2
Not reported	3.0	1.2	.6	2.3	2.3	1.8	.5	.3	2.1	1.1	1.1	1.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

PER CENT IN EACH DEPARTMENT.

Asphyxiating gas	68.3	8.5	1.7	.....	1.7	.....	.....	2.6	14.5	.....	2.6	100.0
Burning gas	35.3	39.2	3.9	1.0	7.8	.....	6.9	.....	4.9	.....	1.0	100.0
Exploding gas	40.0	30.0	.....	.....	.....	.....	2.0	12.0	16.0	.....	.....	100.0
Hot-metal explosions and spills	40.5	43.7	1.3	1.3	1.2	0.4	6.2	1.9	2.9	.....	.6	100.0
Furnace breakouts	41.8	56.4	.....	.....	.....	.....	1.8	.....	.....	.....	.....	100.0
Furnace slips	88.7	.....	.....	.....	.....	.....	.....	4.2	6.3	.....	.7	100.0
Hot water and steam	41.5	11.7	4.3	3.2	2.1	.....	4.3	6.4	25.5	.....	1.1	100.0
Electricity	10.2	5.9	10.2	5.1	7.6	14.4	5.1	.8	36.4	4.2	.....	100.0
Nails, splinters, etc	24.2	11.7	1.7	4.2	10.0	1.7	3.3	12.5	25.0	.8	5.0	100.0
Belts, gears, etc	16.3	4.7	.....	11.6	2.3	18.6	.....	4.7	39.5	.....	2.3	100.0
Cranes	4.5	24.4	7.2	8.7	5.1	10.6	17.0	9.2	9.3	3.5	.3	100.0
Locomotives, cars, etc	8.3	16.3	2.1	2.8	.6	2.5	.9	54.3	9.5	2.1	.6	100.0
Switches	.....	5.9	.....	.....	.....	.....	.....	94.1	.....	.....	.....	100.0
Flying scale	23.8	13.2	3.3	6.6	3.0	1.0	8.9	9.6	28.8	1.7	1.0	100.0
Falling and flying objects	20.9	18.4	5.0	8.2	8.2	3.4	4.7	14.7	13.9	1.5	1.1	100.0
Metal in usual motion	1.9	.....	.9	38.3	19.6	36.4	.....	.9	1.9	.....	.....	100.0
Metal in unusual motion	.....	.....	.....	47.1	17.6	23.5	.....	.....	11.8	.....	.....	100.0
Handling stock	26.6	20.6	4.5	6.3	6.3	4.1	3.9	19.3	6.9	.2	1.3	100.0
Lifting weights	11.8	33.3	.....	5.9	.....	.....	7.8	17.6	21.6	.....	2.0	100.0
Handling material in process	1.9	.....	3.7	43.1	25.9	14.8	.9	4.2	5.6	.....	.....	100.0
Piling, loading, etc.	.9	.....	2.8	70.6	1.8	12.8	.....	10.1	.9	.....	.....	100.0
Using tools	19.5	18.8	6.1	13.9	2.2	6.3	3.2	6.6	22.4	.....	1.0	100.0
Operating machines	16.2	10.4	5.2	12.9	6.8	4.9	1.9	4.5	35.3	1.9	.....	100.0
Falls	22.0	15.7	4.6	9.3	3.5	5.6	2.7	10.9	21.9	1.7	2.3	100.0
Yard conditions	19.0	16.7	4.8	7.1	8.3	4.8	3.6	16.7	16.7	.....	2.4	100.0
Unclassified	17.6	15.9	3.5	5.3	1.8	4.1	7.1	9.4	28.2	1.8	5.3	100.0
Not reported	38.4	12.3	1.4	12.3	7.2	5.2	1.4	2.2	18.1	.7	.7	100.0
Total	22.6	18.8	4.2	9.6	5.7	5.1	4.9	11.7	15.2	1.2	1.1	100.0

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Injuries from flying and falling objects constitute the greater per cent of injuries in all but one of the departments. In the foundry the operations of cranes is responsible for 28 per cent of the injuries, while 24.3 per cent are due to flying and falling objects. The percentages due to this latter cause in the different departments are as follows: Blast furnaces, 23.3; steel works, 24.6; blooming mills, 30.4; rail mills, 21.6; plate mills, 36.2; structural mills, 17.1; foundry, 24.3; yards, 31.7; mechanical and electrical, 22.9; docks, 31.2; miscellaneous departments, 25. The only other cause of injury approaching this in percentage of cases is the falls of the workmen, which on the average are responsible for 10.5 per cent of all injuries.

It may be remarked in this connection that the large proportion of injuries arising from falling and flying objects sheds some light upon the probable responsibility of the workmen for the injuries which they receive. It is quite inconceivable that for any large part of this group of injuries a workman would be able to foresee and provide against the occurrence by any degree of caution which he could exercise. This consideration reenforces the statement [1] made in discussing the proportion of accidents which it seems reasonable to regard as distinctly the "hazards of the industry" and for which responsibility can not be placed either upon the workman or his employer.

The third section of the table shows under each cause of injury the per cent of injuries which happened in each department. In blast furnaces were found 68.3 per cent of the injuries caused by asphyxiating gas, 40.0 per cent of those caused by exploding gas, 88.7 per cent of those caused by furnace slips, 20.9 per cent of those caused by flying and falling objects, 41.5 per cent of those caused by hot water and steam, 26.6 per cent of those caused by handling material, 22.0 per cent of those caused by falls, and 19.0 per cent of those caused by yard conditions. In steel works were found 39.2 per cent of those caused by burning gas, 43.7 per cent of those caused by hot-metal explosions and spills, 56.4 per cent of those caused by furnace breakouts, and 24.4 per cent of those caused by operation of cranes. In rolling mills the rail mill has the high percentages, as follows: 38.3 per cent of injuries caused by usual passage of metal, 47.1 per cent of those caused by unusual passage of metal, 43.1 per cent caused by handling metal during processes, and 70.6 per cent of those caused by piling, loading, etc.

Some further explanation regarding usual and unusual passage of metal should be given at this point. In the arrangement of rolling mills it was formerly nearly universally the case that no adequate provision was made for the safe passage of workmen from one side of the mill to the other. They must either clamber over the roll

[1] See pp. 173 and 174.

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tables or possibly crawl under them, or there may have been at some points narrow passageways across which the hot metal was passing constantly and through which it was not expected that workmen would undertake to go. In the absence of provisions for safe transit workmen were more or less frequently caught by moving masses of metal and injured. Of occurrences of this kind in the plant under consideration 0.9 per cent occur in the blooming mill, 38.3 per cent in the rail mill, 19.6 per cent in the plate mill, and 36.4 per cent in the structural mill during the period of six years. Elsewhere [1] it will be shown that by proper safeguarding these accidents were almost entirely eliminated at a certain point in the period. Besides these cases, which may be regarded as chargeable in part to the employer who provided no means of transit and in part to the workmen who took reckless chances, there are other cases in which the hot bar of metal leaves its ordinary course and in so doing may possibly injure anyone who may be in the vicinity. Of occurrences of this kind 47.1 per cent happen to employees of the rail mill, 17.6 per cent to employees of the plate mill, and 23.5 per cent to employees of the structural mill. Besides these, 11.8 per cent happened to mechanics engaged in repairs about the mills who were caught by the wandering masses of metal. In connection with the discussion of the elimination of accidents from metal moving in its ordinary course some further comment upon these unusual occurrences will appear.

The yard department naturally has the highest percentage in two causes of injury, the operation of locomotives and cars, 54.3 per cent, and the operation of railway switches, 94.1 per cent.

The mechanical and electrical departments head the list in accidents caused by electricity, 36.4 per cent; those caused by projecting nails, splinters, etc., 25 per cent; those caused by belts and gears, 39.5 per cent; those caused by the use of tools, 22.4 per cent; and those caused by the operation of machines, 35.3 per cent.

The following table presents the causes of injury from another standpoint. They are here arranged by years in order to show both their relative prevalence in the different years and to show the changes which have occurred in progress of time.

[1] See p. 142.

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CAUSES OF INJURY IN PLANT INVESTIGATED, BY YEARS, 1905 TO 1910.

NUMBER OF INJURIES (FATAL AND NONFATAL).

Causes of injury.	1905	1906	1907	1908	1909	1910	Total.
Asphyxiating gas	10	40	17	6	18	26	117
Burning gas	10	26	16	12	16	22	102
Exploding gas	13	16	12	6	2	1	50
Hot-metal explosions and spills	170	147	173	50	82	69	691
Furnace breakouts	1	22	13	1	12	6	55
Furnace slips	56	33	25	21	4	3	142
Hot water and steam	32	14	18	6	13	11	94
Electricity	25	27	26	7	13	20	118
Nails, splinters, etc	34	23	15	11	20	17	120
Belts, gears, etc	10	9	12	5	1	6	43
Cranes	120	112	107	65	124	94	622
Locomotives, cars, etc	81	83	54	20	50	38	326
Switches	2	7	1	1	1	5	17
Flying scale	106	34	47	25	64	26	302
Falling and flying objects	488	381	370	187	260	266	1,952
Metal in usual motion	29	29	36	1	7	5	107
Metal in unusual motion	7	.....	2	3	3	2	17
Handling stock	104	94	73	33	71	87	462
Lifting weights	8	12	8	9	9	5	51
Handling material in process	65	48	8	18	39	38	216
Piling, loading, etc	14	19	14	8	23	31	109
Using tools	110	73	85	22	62	58	410
Operating machines	101	91	83	46	47	57	425
Falls of the worker	202	171	149	91	103	94	810
Yard conditions	13	19	16	11	10	15	84
Unclassified	70	23	34	13	17	13	170
Not reported	40	53	20	7	13	5	138
Total	1,921	1,606	1,434	685	1,084	1,020	7,750

PER CENT FROM EACH CAUSE.

Asphyxiating gas	0.5	2.5	1.2	0.9	1.7	2.5	1.5
Burning gas	.6	1.6	1.1	1.8	1.5	2.2	1.3
Exploding gas	.7	1.0	.8	.9	.2	.1	.6
Hot-metal explosions and spills	8.8	9.2	12.1	7.7	7.6	6.7	8.9
Furnace breakouts	.1	1.4	.9	.1	1.1	.6	.7
Furnace slips	2.9	2.1	1.7	3.1	.4	.3	1.8
Hot water and steam	1.7	.9	1.3	.9	1.2	1.1	1.2
Electricity	1.3	1.7	1.8	1.0	1.2	2.0	1.5
Nails, splinters, etc	1.8	1.4	1.0	1.6	1.8	1.7	1.5
Belts, gears, etc	.5	.6	.8	.7	.1	.6	.6
Cranes	6.2	7.0	7.5	9.5	11.4	9.2	8.0
Locomotives, cars, etc	4.2	5.2	3.8	2.9	4.6	3.7	4.2
Switches	.1	.4	.1	.1	.1	.5	.2
Flying scale	5.5	2.1	3.3	3.6	5.9	2.5	3.9
Falling and flying objects	25.4	23.7	25.8	27.3	24.0	26.1	25.2
Metal in usual motion	1.5	1.8	2.5	.1	.6	.5	1.4
Metal in unusual motion	.4	.....	.1	.4	.3	.2	.2
Handling stock	5.4	5.9	5.1	4.8	6.5	8.5	6.0
Lifting weights	.4	.7	.6	1.3	.8	.5	.7
Handling material in process	3.4	3.0	.6	2.6	3.6	3.7	2.8
Piling, loading, etc	.7	1.2	1.0	1.2	2.1	3.0	1.4
Using tools	5.7	4.5	5.9	3.2	5.7	5.7	5.3
Operating machines	5.3	5.7	5.8	6.7	4.3	5.6	5.5
Falls of the worker	10.5	10.7	10.4	13.3	9.5	9.2	10.3
Yard conditions	.7	1.2	1.1	1.6	.9	1.5	1.1
Unclassified	3.6	1.4	2.4	1.9	1.6	1.3	2.2
Not reported	2.1	3.3	1.4	1.0	1.2	.5	1.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

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CAUSES OF INJURY IN PLANT INVESTIGATED, BY STATES, 1905 TO 1910—Concluded.

RATES PER 1,000 300-DAY WORKERS.

Causes of injury.	1905	1906	1907	1908	1909	1910	Total.
Asphyxiating gas	1.6	5.3	2.2	1.4	3.0	3.4	2.9
Burning gas	1.6	3.5	2.1	2.7	2.6	2.9	2.6
Exploding gas	2.0	2.1	1.6	1.4	.3	.1	1.3
Hot-metal explosions, etc	**26.5**	**19.6**	**22.8**	**11.4**	**13.2**	**9.0**	**17.4**
Furnace breakouts	.2	2.9	1.7	.2	1.9	.8	1.4
Furnace slips	8.7	4.4	3.3	4.8	.6	.4	3.6
Hot water and steam	5.0	1.9	2.4	1.4	2.1	1.4	2.4
Electricity	3.9	3.6	3.4	1.6	2.1	2.6	3.0
Nails, splinters, etc	5.3	3.1	2.0	2.5	3.2	2.2	3.0
Belts, gears, etc	1.6	1.2	1.6	1.1	.2	.8	1.1
Cranes	**13.7**	**14.9**	**14.1**	**14.2**	**20.0**	**12.3**	**15.6**
Locomotives, cars, etc	12.6	11.1	7.1	4.4	8.0	5.0	8.2
Switches	.3	.9	.1	.2	.2	.7	.4
Flying scale	16.5	4.5	6.2	5.7	10.3	3.4	7.6
Falling and flying objects	**76.2**	**50.8**	**48.8**	**42.7**	**41.8**	**34.8**	**49.1**
Metal in usual motion	4.5	3.9	4.7	.2	1.1	.7	2.7
Metal in unusual motion	1.1	.....	.3	.7	.5	.3	.4
Handling stock	16.2	12.5	9.6	7.5	11.4	11.4	11.6
Lifting weights	1.2	1.6	1.1	2.1	1.4	.7	1.3
Handling material in process	10.1	6.4	1.1	4.1	6.3	5.0	5.4
Piling, loading, etc	2.2	2.5	1.8	1.8	3.7	4.1	2.7
Using tools	17.2	9.7	11.2	5.0	10.0	7.6	10.3
Operating machines	15.8	12.1	10.9	10.1	7.6	7.5	10.6
Falls of the worker	**31.5**	**22.8**	**19.7**	**20.8**	**16.6**	**12.3**	**20.3**
Yard conditions	2.0	2.5	2.1	2.5	1.6	2.0	2.1
Unclassified	10.9	3.1	4.5	2.8	2.7	1.7	4.3
Not reported	6.2	7.1	2.6	1.5	2.1	.7	3.5
Total	300.0	214.3	189.1	149.7	174.0	133.5	.....

The figures for the four causes which give rise to the greatest number of injuries are emphasized by being printed in bold-faced type. These causes are hot-metal explosions and spills, the operation of cranes, flying and falling objects, and the falls of the worker.

With reference to the second section of the table, where the percentages for each cause in each year are shown, it would appear that over 50 per cent of all the accidents occurring arise from these four causes, distributed as follows: Hot-metal explosions and spills, 8.9 per cent; operation of cranes, 8 per cent; flying and falling objects, 25.2 per cent; and falls of the worker, 10.3 per cent. It is further of interest in this section of the table to notice that the percentage of accidents arising from individual causes has in very few instances materially changed in the course of the six years. In the chief cause, namely, flying and falling objects, the highest percentage is 27.3 and the lowest 23.7. Some of the other causes specified are less constant, but on the whole show the same condition.

The third section of the table presents the rates per 1,000 of 300-day workers for each of these causes of injury. It has just been seen that the causes maintain from year to year a substantially unchanged relation to each other. In the third section may be noticed the nature and the direction of change in each cause from year to year. For example, take the series representing hot-metal explosions. In the successive years the rates are 26.5, 19.6, 22.8, 11.4, 13.2, and 9; that is, in the year 1905 for every thousand men employed in the

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plant nearly 27 were injured by explosions of hot metal. In the year 1910, 9 per 1,000 were so injured. In the case of flying and falling objects in 1905, 76.2 men per 1,000 suffered injury; in 1910, 34.8. In 1905, 31.5 men per 1,000 fell from a height and were injured; in 1910, 12.3 men per 1,000 suffered injury in this way.

There appear in this table two very remarkable instances of the immediate effectiveness of safeguarding methods. In the case of furnace slips, by which ore or burning coke was thrown from the blast furnaces, the rate in 1905 was 8.7 per 1,000; in 1908 it was 4.8, showing a very considerable decrease; in 1909 it fell to 0.6 per 1,000; in 1910 it was only 0.4. Here was a period of four years in which a gradual decline had occurred. The explanation of this decline is that the blast furnaces were undergoing reconstruction and that the new furnaces were of an improved type, and this improvement in type resulted in the gradual decrease of accidents of this character. Early in 1909 a newly invented valve was installed upon the furnaces, by which the escape of stock when slips occurred was effectually prevented. The accident rate at once fell from nearly 5 to less than 1; that is, in 1908, 21 men suffered more or less severe injury from this cause, while in 1909 there were only 4. While this decrease in accident rate would in itself quite justify the installation of the device, it may be said that in addition the company saved by this installation $1,000 per month, which they had before that time been expending in cleaning up the blast-furnace yards.

The other case relates to the movement of metal in the rolling mills, which has already been mentioned. It appears that for the entire six years the accident rate from the usual motion of metal was 2.7, from the unusual motion 0.4. This shows at once the relative importance of these two causes of injury. In 1907 the rate for accidents from the usual motion of metal was 4.7; in the next year it was 0.2. This reduction coincides with a thoroughgoing rearrangement of the gear coverings and bridges over roll tables and other means of safe passage about the mills. Such instances of immediate and striking results from safeguarding effort are not usual. In Appendix G will be found a table giving in detail the direct causes of injury, by both departments and occupations.

NATURE OF INJURY.

In Chapter I (pp. 60 to 71) this subject has been somewhat fully discussed, and the data derived from this plant have been there incorporated. It remains only to indicate the progress which has occurred from year to year and to notice whether this progress is particularly marked in the case of certain kinds of injury.

The table which follows presents this matter, showing first the number of injuries of each nature, and second, the rates per 1,000 300-day workers.

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NATURE OF INJURY IN PLANT INVESTIGATED, BY YEARS, 1905 TO 1910.

NUMBER OF INJURIES.

Nature of injury.	1905	1906	1907	1908	1909	1910	Total.
PERMANENT INJURIES.							
Loss of arm	.....	.....	1	.....	.....	.....	1
Loss of leg	3	1	1	1	.....	1	7
Loss of thumb	.....	3	3	.....	1	.....	7
Loss of first finger	1	5	.....	.....	2	.....	8
Loss of other fingers	7	5	10	3	4	2	31
Loss of foot	.....	1	.....	1	.....	1	3
Loss of eye	3	3	2	.....	1	.....	9
Loss of both eyes	.....	.....	1	.....	.....	.....	1
Total permanent injuries	14	18	18	5	8	4	67
TEMPORARY DISABILITIES.							
Other eye injuries	126	38	50	28	71	31	344
Fracture of arm	6	17	10	2	13	8	56
Fracture of both arms	.....	1	.....	1	1	.....	3
Fracture of leg	15	23	26	8	16	14	102
Fracture of both legs	.....	.....	1	.....	1	.....	2
Fracture of ribs	3	3	7	2	.....	2	22
Fractures not specified	6	10	13	13	18	7	67
Hand crushed or broken	6	3	12	4	3	8	36
Foot or toes crushed or broken	23	40	44	23	27	21	178
Fingers crushed or broken	52	65	70	33	66	70	356
Hand or fingers bruised, etc	376	236	224	116	186	208	1,346
Foot or toes bruised, etc	297	264	196	106	168	172	1,203
Other parts bruised, etc	465	360	305	153	220	203	1,706
Dislocations	124	101	85	41	56	55	462
Punctured wounds	46	45	22	17	29	21	180
Asphyxia	9	27	12	5	15	22	90
Burns by hot metal	106	135	150	29	72	52	544
Burns by falling stock	18	19	18	20	4	1	80
Burns by gas	15	29	17	13	11	16	101
Burns by electricity	20	23	20	7	12	15	97
Burns by steam or water	28	19	20	6	13	10	96
Burns not specified	116	54	70	25	35	43	343
Hernia	2	3	4	1	2	2	14
Pleural injuries	22	22	5	12	18	18	97
Unclassified	6	3	5	1	1	.....	16
Not reported	1	4	5	.....	4	5	19
Total temporary disabilities	1,888	1,549	1,381	668	1,062	1,004	7,562
Total nonfatal injuries	1,902	1,567	1,409	673	1,070	1,008	7,629

RATES PER 1000 300-DAY WORKERS.

Permanent injuries	2.2	2.4	2.4	1.1	1.3	0.5	1.7
TEMPORARY DISABILITIES.							
Injuries to eye	19.7	5.1	6.6	6.1	11.4	4.1	8.6
Fracture of arm	.9	2.3	1.3	.4	2.1	1.0	1.4
Fracture of both arms	.....	.1	.....	.2	.2	.....	.8
Fracture of leg	2.3	3.1	3.4	1.7	2.6	1.8	2.6
Fracture of both legs	.....	.....	.1	.....	.2	.....	.1
Fracture of ribs	.5	1.1	.9	.4	.....	.3	.6
Fractures not specified	.9	1.3	1.7	2.8	2.9	.9	1.7
Hand crushed or broken	.9	.5	1.6	.9	.5	1.0	.9
Foot or toes crushed or broken	3.6	5.3	5.8	5.0	4.3	2.7	4.5
Fingers crushed or broken	8.1	8.7	9.2	7.2	10.6	9.2	8.9
Hand or fingers bruised, etc	58.7	31.5	29.5	25.4	29.9	27.2	33.7
Foot or toes bruised, etc	46.4	35.2	25.9	23.2	27.0	22.5	30.1
Other parts bruised, etc	72.6	48.0	40.2	33.4	35.4	26.6	42.7
Dislocations	19.4	13.5	11.2	9.0	9.0	7.2	11.6
Punctured wounds	7.2	6.0	2.9	3.7	4.7	2.7	4.5
Asphyxia	1.4	3.6	1.6	1.1	2.4	2.9	2.3
Burns by hot metal	16.5	18.0	19.8	6.3	11.6	6.8	13.6
Burns by falling stock	2.8	2.5	2.4	4.4	.6	.3	2.0
Burns by gas	2.3	3.9	2.2	2.8	1.8	2.1	2.5
Burns by electricity	3.1	3.1	2.6	1.5	1.9	2.0	2.4
Burns by steam or water	4.4	2.5	2.6	1.7	2.1	1.3	2.3
Burns not specified	18.1	7.2	9.2	5.5	5.6	5.6	8.6
Hernia	.3	.4	.5	.1	.3	.3	.4
Pleural injuries	3.4	2.9	.7	2.6	2.9	2.4	2.4
Unclassified	.9	.4	.7	.1	.2	.....	.4
Not reported	.2	.5	.8	.....	.6	.7	.5
Total temporary disabilities	294.7	206.7	182.1	146.0	170.9	131.3	189.4
Total nonfatal injuries	296.9	209.1	184.5	147.1	172.2	131.9	191.1

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If the rates for important kinds of injury be compared in the above table it will appear that with few exceptions similar changes are occurring from year to year in each. To state the matter in another form the factors tending to accident reduction appear to have a nearly equal influence on all kinds of injury. The degree of these changes from year to year is readily observable.

A few of the important instances of reduction will be given. In permanent injuries the rate has changed from 2.2 per 1,000 in 1905 to 0.5 per 1,000 in 1910. On account of differences in classification of industries foreign rates are not exactly comparable with these rates, but available data apparently indicate that the item of permanent injury is lower in American mills than it is in those of foreign countries.[1] The explanation lies in the very large use in American practice of mechanical methods. Where large numbers of men are engaged in the direct handling of material there will be a very large number of cases involving injuries to the hands and feet which will be permanent. The loss of a finger or a portion of a finger or simple injuries to the foot will occur much more frequently than where the same results are obtained by the use of mechanical means. In no respect is the contrast more marked between American and foreign mills than in this particular, viz, the use of mechanical methods in America and of hand methods abroad.

Considering now the reduction of permanent injury which has occurred in the plant under consideration in the six years, it is possible to correlate it directly with a considerable expansion of mechanical operation. In the loading beds of the plate mills two methods of moving plates were formerly in use, each involving hand labor. First, chains were fastened about the plates—always a dangerous process—and the plates were then moved by a traveling crane; second, the smaller plates were handled directly by the workmen, who grasped them at the edges by plate wrenches and dragged them over the rolls and finally slid them into the cars. In both these methods accidents resulting in injuries to the hands of greater or less severity were constantly occuring. At the present time the process is carried on entirely by the use of a magnet. The craneman with a single helper now accomplishes what formerly required from 6 to 10 men. The crane moves to the plate or plates desired to be moved, the magnet is lowered, the current turned on, and the plates are dragged away without being touched by the hands of the workman. It is only when the operation goes wrong in some particular that his presence and interference is necessary. It is obvious that such a change as this in methods of manipulation must tend to reduce materially the item of permanent injury. Similar illustrations might be drawn from every department of the plant.

[1] See Twenty-fourth Annual Report of the Commissioner of Labor, Workmen's Insurance and Compensation Systems in Europe, pp. 125 and 1151.

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It has appeared elsewhere that injuries to the eye arise very frequently in connection with the operation of "chipping." The workman by means of a chisel or a pneumatic tool removes roughness and imperfections from the surfaces of steel billets or of castings. Chips of various sizes fly from this process, injuring the worker to some extent and still more other workers in the vicinity. The table shows a reduction in rates from 19.7 in 1905 to 4.1 in 1910. This has been brought about by a persistent experiment in the direction of discovering protective goggles which the workmen will consent to wear. Many forms of these goggles are so undesirable and even injurious from other points of view that it has been difficult to enforce their use. A form has finally been developed which seems both to afford protection and not to have the objectionable features of the earlier types. With the general use of these goggles injuries to the eye of this character should almost entirely disappear. Bruising injuries to the hands have declined in rates from 58.7 to 27.2, of the feet from 46.4 to 22.5, while bruises of other parts of the body show a diminution from 72.6 to 26.6. Dislocations change in rates from 19.4 to 7.2; burns by hot metal from 16.5 to 6.8.

Since it has been noted that both in steel works and in blast furnaces a very high proportion of the injuries occurring are those in connection with molten metal, the reduction in rates from burns is exceedingly important. It is really of rather recent occurrence, inasmuch as in the first three of the six years a rise in the rate will be noted. It comes about quite largely from two causes: First, a much more rigid application of operative rules tending to lessen the number of burns; and second, very considerable improvements in the methods used in handling the molten metal. For example, the huge ladles used for carrying the metal from one point to another are suspended, for convenience in pouring, at a point but slightly above the center of gravity. As a result, if the ladle is somewhat overfilled, there is considerable liability that some sudden impulse will overturn the ladle, causing a dangerous "spill." By modifying the form of the trunnions on which the ladle was tipped and by providing more adequate locking devices, to prevent the sudden overturning of the ladle, it has been possible very largely to eliminate these occurrences, and the rate for burns arising from them has fallen accordingly.

In this table, as in another which has already been discussed, the sudden diminution of injury from stock ejected by the blast furnace again appears. In 1908 the rate for such injury was 4.4, falling in 1909 to 0.6 and in 1910 to 0.3. These figures do not agree exactly with those before given, since these include only the injuries from burns while the others included also bruises, etc., arising from this cause.

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The fact that the danger from the electrical current is decidedly less than it has been generally believed to be has been brought out at another point. It appears again in this table in that the rate for burns from this cause in 1905 was 3.1, falling to 1.9 in 1909, and 2 in 1910. This decrease is not very marked because the possible precautions introduced in the course of this period were not many. The covering of fuses, so that in case they burn out on the closing of the circuit there may not be a flash which will cause a burn, has been carried out throughout the mills. Many wires which heretofore ran uncovered are now carried in pipe conduits. By means of these precautions some reduction in the burns due to this cause is possible. It will be understood that these rates are based upon the entire number of employees in the plant and do not represent the hazard of those specially employed in connection with particular occupations.

RELATION OF OPERATIONS TO INJURY.

In the following table an effort is made to assemble the cases of injury for a period of six years in such a way as to disclose the operations in connection with which they occur. Five groups of operations are represented: First, the stocking and charging of materials; second, operations with molten metal; third, operations with hot solid metal; fourth, operations with cold metal; fifth, accessory operations.

OPERATIONS IN WHICH NONFATAL INJURIES ARE CONNECTED IN SPECIFIED DEPARTMENTS.

Operations.	Number of injuries.						Per cent of injury occurring in connection with each kind of operation.					
	Blast furnaces.	Steel works.	Rolling mills.	Yards.	Mechanical.	Total.	Blast furnaces.	Steel works.	Rolling mills.	Yards.	Mechanical.	Total.
Stocking and charging materials	304	502	3	27	4	840	17.4	34.5	0.2	3.0	0.4	11.9
Molten metal:												
Tapping	431	176	.....	.....	1	608	24.6	12.1	.....	.....	.1	8.6
Pouring	8	161	.....	.....	.....	169	.5	11.1	.....	.....	.....	2.4
Transportation	40	104	.....	4	2	150	2.3	7.2	.....	.4	.2	2.1
Ingot explosions	.....	40	.....	.....	.....	40	.....	2.8	.....	.....	.....	.6
Total	479	481	.....	4	3	967	27.4	33.2	.....	.4	.3	13.7
Hot solid metal:												
Transportation	.....	6	14	4	.....	24	.....	.4	0.7	.4	.....	.3
Heating	.....	.....	28	.....	3	31	.....	.....	1.5	.....	.3	.4
Rolls	.....	.....	29	.....	.....	29	.....	.....	1.5	.....	.....	.4
Tables	.....	.....	145	.....	2	147	.....	.....	7.6	.....	.2	2.1
Beds	.....	.....	217	.....	3	220	.....	.....	11.4	.....	.3	3.1
Shearing, etc	.....	.....	33	.....	1	34	.....	.....	1.7	.....	.1	.5
Total	.....	6	466	4	9	485	.....	.4	24.6	.4	.9	6.9
Cold metal:												
Transportation	5	4	299	20	15	343	.3	.3	15.8	2.2	1.4	4.9
Shearing, etc	.....	.....	105	8	5	118	.....	.....	5.5	.9	.5	1.7
Piling and loading	1	.....	187	31	2	221	.1	.....	9.9	3.4	.2	3.1
Total	6	4	591	59	22	682	.4	.3	31.1	6.5	2.1	9.7

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OPERATIONS IN WHICH NONFATAL INJURIES ARE CONNECTED IN SPECIFIED DEPARTMENTS—Concluded.

Operations.	Number of injuries.						Per cent of injury occurring in connection with each kind of operation.					
	Blast furnaces.	Steel works.	Rolling mills.	Yards.	Mechanical.	Total.	Blast furnaces.	Steel works.	Rolling mills.	Yards.	Mechanical.	Total.
Accessory operations:												
Gas producers	.....	69	28	.....	6	103	.....	4.7	1.5	.....	0.6	1.5
Yard operations	21	31	22	385	38	497	1.2	2.1	1.2	42.6	3.6	7.0
Construction and repair	337	108	248	20	643	1,356	19.3	7.4	13.1	2.2	61.4	19.2
Machines and motive power	47	17	31	6	140	291	2.7	1.2	4.3	.7	13.4	4.1
Care of machines	39	3	31	1	20	94	2.2	.2	1.6	.1	1.9	1.3
Care of boilers	10	.....	3	.....	1	14	.6	.....	.2	.....	.1	.2
General labor	418	166	325	369	71	1,349	23.9	11.4	17.1	40.8	6.8	19.1
Total	872	394	738	781	919	3,704	49.9	27.0	38.9	86.4	87.7	52.5
Unclassified	77	60	93	25	90	345	4.4	4.1	4.9	2.8	8.6	4.9
Not reported	11	7	7	4	1	30	.6	.4	.4	.4	.1	.4
Total	88	67	100	29	91	375	5.0	4.5	5.3	3.2	8.7	5.3
Grand total	1,749	1,454	1,898	904	1,048	7,053	100.0	100.0	100.0	100.0	100.0	100.0

Considering the total percentage column, it is found that 11.9 per cent of cases of injury arise in stocking and charging, 13.7 per cent with molten metal, 6.9 per cent with hot solid metal, 9.7 per cent with cold metal, and 52.5 per cent with the accessory operations. As shown on page 57 the distribution of cases of injury among the different groups would be somewhat different from the distribution according to relative severity. The characteristic steel works operations would show a greater importance while the accessory operations would show a lessened importance. This relation of severity to the different operations should be borne in mind throughout the discussion.

The blast furnaces naturally show nearly all their injuries in three groups—the stocking and charging, the molten metal, and the accessory operations. In those injuries arising in connection with molten metal, 24.6 per cent of all accidents belong to the operation of tapping. Pouring and transportation are relatively unimportant, with 0.5 per cent and 2.3 per cent, respectively. Under accessory occupations, construction and repair give rise to 19.3 per cent of the cases, and 23.9 per cent occur in connection with general labor. Regarding the percentage shown in construction and repair it should be stated that construction work, wherever carried on, is recognized as being especially hazardous. It is frequently conducted in the mills by outside contractors who are not bound by such safety rules as the mill may have adopted. In the construction of staging and the use of hoisting machinery constructors have been up to the present time very lax in taking necessary precautionary measures. This is due in part at least to the fact that their business location is

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continually shifting. This makes it more difficult for the constructor to maintain a satisfactory system of inspection and also makes it less likely that he will be subject to the inspection of the State bureau in the locality where he is engaged. It may easily happen that he undertakes a work of construction, completes it, and removes from the State before the inspection bureau in the regular course of its activity reaches the locality. This emphasis is placed upon the amount of injury arising in connection with construction work since the same difficulties are in a measure to be found in the conduct of a plant.

The steel works show a very high per cent of injuries both in the stocking of materials and in the handling of molten metal; in fact, 68 per cent of all accidents in this department are connected with these operations. It is possible that a portion of those assigned to stocking and charging really belong in the molten-metal group, inasmuch as a part of the raw material handled in the steel works is molten metal received from the blast furnaces. These percentages show that in the steel works the characteristic operations are those of greatest importance from the safety standpoint. They are particularly difficult to guard against, but the fact that steel works show during the six year period covered a considerable reduction in rates of injury indicates that the problem is not an insoluble one. In the accessory occupations in the steel works construction and repair and general labor are the more important, with 7.4 and 11.4 per cent, respectively, of the injuries.

That hot solid metal and the handling of cold metal should be operations fraught with danger seems natural. The table shows that 24.6 per cent of all the injuries in rolling mills occur in connection with hot solid metal. Nineteen per cent of injuries in rolling mills are connected with the operation of the roll tables and of the cooling beds, while less than 2 per cent arise in the operation of the rolls themselves. It is altogether probable that these proportions would be considerably modified in a group of mills where hand operation was a large factor. In rod mills and bar mills the direct handling of the metal by tongs and hooks exposes the workmen to hazards which are not to be found in the mechanically operated mills. The figures indicate that the handling of cold metal gives rise to a considerably larger percentage (31.1 per cent) of injuries than the handling of hot metal (24.6 per cent). The transportation of the cold metal, much of which is done by traveling cranes, is responsible for the larger share (15.8 per cent). The importance of the use of cranes as a source of injury has been shown elsewhere (pages 235 and 236). Since this importance is emphasized by the percentage just shown for transportation in the rolling mills it should be noted that a con-

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siderable portion of this injury is due to the use of imperfect hooks and of chains not thoroughly and carefully inspected.

Data secured during this investigation indicate that the group of injuries arising from crane transportation has been very materially reduced by attention to the points just mentioned. It is, however, one of the sources of danger which is not yet thoroughly controlled.

Among the accessory occupations in the rolling mills construction and repair and general labor have high percentages (13.1 and 17.1 per cent).

In the yards it is almost entirely in connection with the accessory occupations that the injuries occur, 86.4 per cent of all belonging to this group. They divide between yard operations proper, 42.6 per cent, and general labor, 40.8 per cent. The handling of cold metal causes 6.5 per cent of all the cases, while scattering fractional per cents are found in the other groups.

In the mechanical occupations, inasmuch as the mechanics are employed in connection with various operations throughout the plant, there appear scattering cases of injury in almost every one of the groups. Their high percentage is in accessory occupations (87.7 per cent) and of these construction and repair furnish 61.4 per cent and the operation of machines 13.4 per cent of all injuries.

It is believed that this presentation discloses clearly the desirable points of attack in safety work. It is always true in such an effort that the law of diminishing returns becomes immediately operative. In the German mills, for example, it appears that with the methods which they have applied they reached some years ago a condition in which the accident rates are nearly constant. A similar result is to be expected in the development of safety effort in this country, and a careful analysis from time to time of the situation along the lines suggested by this presentation should furnish information as to the points where the results have been least satisfactory and which should accordingly receive most careful attention.

ACCIDENTS AND THE LONG TURN.

In continuous operations, such as those of the blast furnace, the shift of the men working during the day to the night turn has until very recently everywhere involved one of two things, either that one shift should work for 24 hours continuously or that each of the shifts should have a period of 18 hours of continuous labor. In the blast furnace of the plant under consideration up to the time of the investigation the long turn of 24 hours had been the rule and the change of turn was made on Sunday. Since it appeared that this long stretch of activity might in some way be reflected in the accident rate, it was determined to examine that situation with special care. The im-

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pression among the officials of the establishment was very strong that Sunday did not show a higher accident rate. This impression, however, was based entirely upon the number of accidents occurring on that day and did not represent a consideration of the exact relation of this number to the number of people employed. In considering the discussion which follows it should be borne in mind that the numbers involved are small and that additional data covering a large number of establishments would be necessary to warrant definite conclusions.

In order to determine the relation of the Sunday working force to that of other days, a number of exact force reports were obtained and from these it was found that the usual force of Sunday was 82 per cent of the force employed on other days.

The occupations of Sunday are so nearly equal in danger to those of other days that no allowance needs to be made for any difference which may exist.

The following table presents the rates calculated on the basis that the Sunday force is 82 per cent of the week-day force. For the entire period of six years it appears that the rate for Sunday is distinctly, though not greatly, above that of each of the other days.

DISTRIBUTION OF ACCIDENTS IN DAYS OF WEEK IN BLAST FURNACES, 1905 TO 1910.

NUMBER OF 300-DAY WORKERS.

Classification of force, and days.	1905	1906	1907	1908	1909	1910	Total.
Week-day force	961	1,262	1,177	993	1,134	1,081	6,608
Sunday force, 82 per cent of week-day force	788	1,035	965	814	930	886	5,419

NUMBER OF INJURIES.

Monday	51	69	49	29	27	23	248
Tuesday	66	82	37	30	33	17	265
Wednesday	80	51	56	24	38	22	271
Thursday	49	61	47	20	31	30	238
Friday	50	56	54	34	35	28	257
Saturday	51	50	39	32	24	40	236
Sunday	64	49	40	25	32	24	234

RATES PER 1,000 300-DAY WORKERS.

Monday	53.0	54.7	41.6	29.2	23.8	21.3	37.5
Tuesday	68.7	65.0	31.4	30.2	29.1	15.7	40.1
Wednesday	83.2	40.4	47.6	24.2	33.5	20.4	41.0
Thursday	51.0	48.3	39.9	20.1	27.3	27.8	36.0
Friday	52.0	44.4	45.9	34.2	30.9	25.9	38.9
Saturday	53.1	39.6	33.1	34.2	21.2	37.0	35.
Sunday	81.2	47.3	41.5	30.7	34.4	28.2	43.2

Into the rates for the individual years there intrudes a disturbing influence whose action has been apparent in the distribution by hours. This is the mass accident. In the distribution in the hours of the night its effect was apparent in producing irregularity in the small groups. As these were aggregated the irregularity disappeared and the curve

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approached the form characteristic of the day where the groups were larger. Since the probability that a mass accident will occur on some other day than Sunday is six to one, the chance for irregularity is considerable. Examination of the records indicates that the days of the individual years which show a rate higher than Sunday do so in several instances because of mass accidents which occurred upon those days.

On the whole this presentation seems to indicate a slight tendency to greater frequency of accidents on the day of the long turn.

A showing of this kind, even over a period of six years, may be purely accidental. The inquiry is therefore extended to other plants as far as fairly adequate data are available.

In the case of the plant now to be considered, the manner of determining the relation of the Sunday and week day force was as follows: The force is made up of turn men who work 12 hours, and day workers who have a 10-hour day. On week days the turn men numbered 521 and the day workers 378. On Sundays the numbers were 446 and 74. To compare satisfactorily, some common basis must be used for week days and Sundays. The simplest method is reduction to a 12-hour basis. The hazard of 10 hours work is five-sixths of that of 12 hours. Adding, therefore, five-sixths of the 10-hour men to the number of 12-hour men gives for week days, an equivalent of 836 12-hour men and for Sundays 508.

Calculating rates with these numbers as bases it is found that the Sunday rate is markedly higher than for other days. The possibility of the disturbing influence of mass accidents must be considered. The records show that none of the mass accidents occurred on Sunday and therefore its high rate can not be explained on that basis. A rather strong tendency to frequency of ordinary accidents seems here to be evident in connection with the long turn. The distribution of accidents in this plant is shown in the following table:

DISTRIBUTION OF ACCIDENTS IN DAYS OF WEEK AND MONTHS IN A LARGE BLAST FURNACE FOR TWO YEARS.

Months.	Sunday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.
January	5	2	1	2	4	3	4
February	2	2	.....	.....	.....	.....	3
March	2	2	4	3	3	3	1
April	.....	3	1	1	1	1	1
May	1	1	.....	2	2	1	.....
June	1	4	2	3	7	2	2
July	4	.....	2	.....	2	3	5
August	3	2	6	3	.....	2	3
September	2	1	1	2	3	2	.....
October	3	.....	1	2	3	4	6
November	1	3	3	1	1	1	.....
December	2	1	1	2	2	1	4
Total accidents	26	21	22	21	28	23	29
Number of employees	508	836	836	836	836	836	836
Rates per 1,000 employees	51.2	25.1	26.3	25.1	33.5	27.5	34.7

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The distribution of accidents in two other plants, both of which were blast furnaces, is shown in the following table, the data covering two years in each case. In the first plant all the employees, and in the second 79 per cent of the employees were on duty on Sunday.

DISTRIBUTION OF ACCIDENTS IN DAYS OF THE WEEK IN TWO PLANTS, BY MONTHS.

BLAST FURNACE, 2 YEARS (ALL EMPLOYEES ON DUTY SUNDAY).

Months.	Sunday.	Monday.	Tuesday.	Wednesday.	Thursday.	Friday.	Saturday.
January	3		3		1	1	1
February	1	2	1	2		1	
March	1	1	1	2	1	2	4
April	1	1	1				2
May	4		2	1		2	
June	1	1	1		1		
July	1		2				
August	1	1			2		2
September		1		2	1		
October	2	4				1	
November	1	1	2	2	1		
December				2	1		
Total	16	12	13	11	8	7	9
Number of employees	248	248	248	248	248	248	248
Rates per 1,000 employees	64.5	48.4	52.4	44.4	32.3	28.2	36.3

BLAST FURNACE, 2 YEARS (79 PER CENT OF EMPLOYEES ON DUTY SUNDAY).

January	1	1	1	3	2		2
February	1	4	3				2
March	3	1		3	1	3	2
April	1	1	1	3	3	2	1
May	1	3	1	1	1	2	3
June	4	6	1	2	2	1	3
July	1		2		3	2	1
August	2	1			1	2	2
September	2	2	3	6		2	3
October	2		2			3	2
November	1	2	3	2	3		1
December	1	2	1	4	3	2	
Total	20	23	18	24	19	19	22
Number of employees	361	457	457	457	457	457	457
Rates per 1,000 employees	55.4	50.3	39.4	52.5	41.6	41.6	48.1

The first part of the above table shows for one blast furnace the number of accidents in each day of the week for two years. The rate for Sunday considerably exceeds that of any other day. In the furnace shown in the second part for two years the Sunday rate also exceeds that of week days, but not to as great an extent as in the other furnace.

These studies do not cover a sufficient number of cases or a long enough period of time to justify positive conclusions, but the furnaces in which it was possible to determine the facts all show a tendency to greater frequency of accident during the long turn.

ACCIDENTS IN DAY AND NIGHT.

In this, as in the question of accidents on the day of the long turn, the impression of men familiar with the industry has been very strong that the night did not show any excess over the day; but the

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impression so far as observed had been derived entirely from consideration of the number of accidents, without due consideration of the number of workmen employed.

The following table shows the accident rates per 1,000 300-day workers for the day and night periods, by years, with per cent of excess of night over day rates:

COMPARISON OF DAY AND NIGHT ACCIDENT RATES PER 1,000 300-DAY WORKERS IN THE PLANT INVESTIGATED BY YEARS, 1905 TO 1910.

Years.	Accident rates per 1,000 300-day workers.		
	Day.	Night.	Per cent of excess of night over day rates.
1905	245	285	16.3
1906	183	219	19.7
1907	164	203	23.8
1908	174	100	[1] 74.0
1909	166	187	12.7
1910	127	132	3.9
Six years, 1905 to 1910	173	193	11.6

[1] Excess of day rate over night rate. Many dangerous occupations were entirely suspended at night during the year.

While it must be recognized that for positive conclusions a large mass of data is necessary, it is significant that in the plant under consideration the night rates are in excess of the day rates in each year except 1908. Throughout the discussion this year has constantly shown an exceptional character. It has been explained that it was a year of great depression. Throughout a very large part of the year many hazardous occupations were entirely suspended during the night. Inevitably in this condition the rate for night accidents very markedly declined.

The rates are shown for the principal departments in the following table:

COMPARISON OF DAY AND NIGHT ACCIDENT RATES PER 1000 300-DAY WORKERS IN THE PLANT INVESTIGATED, BY PRINCIPAL DEPARTMENTS, FOR THE PERIOD 1905 TO 1910.

Departments.	Accident rates per 1,000 300-day workers.		
	Day.	Night.	Per cent of excess of night over day rates.
Blast furnaces	238	243	2.1
Bessemer steel works	245	312	27.3
Open-hearth steel works	206	270	31.1
Rolling mills	153	213	39.2
Mechanical	153	334	118.3
Yards	145	330	127.6

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In the blast furnaces the difference between the day rate (238) and the night rate (243) is too small to be significant. Extremely high differences in day and night rates appear in the mechanical and the yard forces, and it is necessary to present an explanation of this condition. The mechanical force in this establishment is exceedingly small at night; while the force occupied during the day is upward of 1,000, that on duty at night does not exceed 100. When, however, this force of 100 men is considered for a period of six years, and its rate appears so very much higher than that of the larger day force, it is clearly significant. Two causes must be operative: (1) The night men are engaged very largely upon repairs, which must be executed speedily. Since the men have few other duties, it may often happen that they are dozing or even asleep when called out for active service. The nature of the work and the physical condition of the man would probably both tend toward a high rate. (2) The lighting of the mills presents a difficult problem, and certainly in the earlier of the years under consideration was so imperfect as to be an important factor in this higher rate.

The night force of yardmen is also smaller than the day force, but their duties do not differ sufficiently to afford an adequate reason for their higher rate. The only influence which it would appear can exert any considerable effect upon their rate is the difference in lighting. The nature of the operations conducted by the yard force make the question of lighting of great importance and the sort of differences which exist between daylight illumination and that which has been used at night in the past in the steel mills would have a great influence upon the safety with which the operations could be conducted.

The facts in regard to day and night are brought out graphically in the diagram on page 155.

In the first three years of the 6-year period it will be seen that the per cent of excess for the night steadily increases. This happened while the general accident rate was falling. The sudden decrease in the night rate in 1908 has already been explained. After 1908 the night rates were higher but did not reach the point shown in the earlier years. The years 1906 and 1907 were of extraordinary activity, which increased up to a late point in 1907. It involved a large and increasing amount of night work. This was especially true in the yard department, where much loading and shipping had to go on in the night in order to keep the loading beds cleared. An increase in accidents followed. No special efforts were being directed toward keeping down the night accidents, and the fact that they were increasing was unknown to the management because the general rate was falling. In the absence of special effort with reference to the night conditions the accident rate rose in proportion to the intensified activ-

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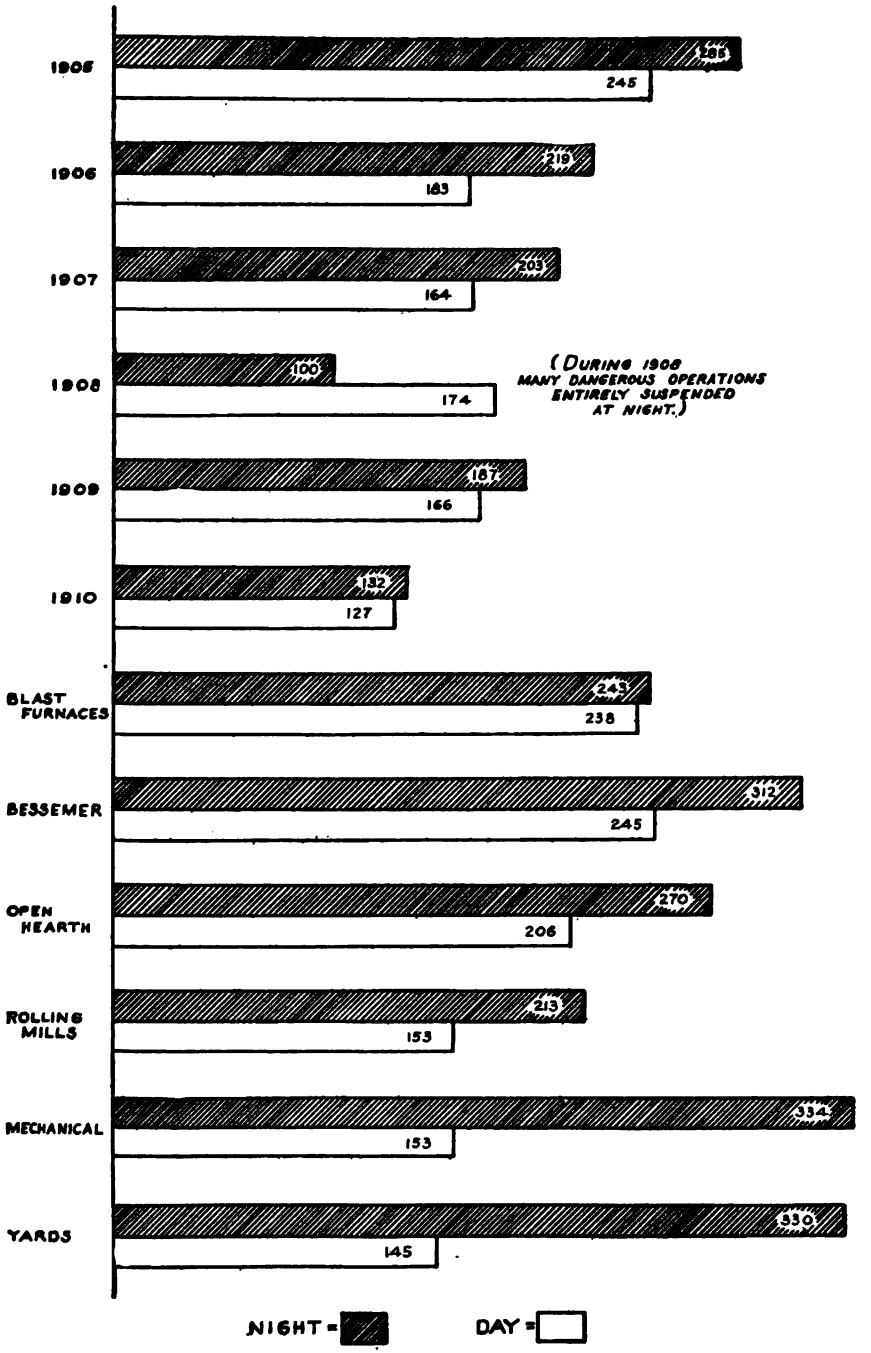
DAY AND NIGHT ACCIDENT RATES PER 1,000 300-DAY WORKERS IN LARGE STEEL PLANT, BY YEARS AND DEPARTMENTS, 1905 TO 1910.



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ity. It is probable that the high rate shown in the yards for the entire period is very largely due to these three years of great activity.

The later years, when activity again somewhat closely approximated that of 1906 and 1907, did not show an equal excess in the night rates. One circumstance must be very closely connected with this fact. Beginning in the depressed year of 1908, when the slackening of other activities permitted attention, progressive effort to improve the lighting throughout the plant was made. The first step was the installation of flaming arc lamps, which give a diffused light in contrast with the ordinary arc lamp which casts very dark and sharp shadows. Later, with the development of the tungsten incandescent lamp, changes were introduced by which the number of lighting units was increased and a better diffusion of light was secured. The reduced night accident rate is probably due in a considerable measure to improved lighting.

COMPARISON OF ESTIMATES OF SURGEONS WITH ACTUAL DISABILITIES.

In connection with the consideration of disabilities and losses of time from accident a discussion is pertinent of the relation between the estimates made by surgeons at the time of the accident and the actual disabilities which are determined at a later period. It appeared that the close relation and long experience of the surgeons in charge of the accidents from this plant should give approximately exact results. In estimating the period of disability it was their custom to give a minimum and a maximum period; for example, that the disability would continue, in their judgment, not less than 14 and not more than 21 days. Obviously it would be unfair to use an average of these estimates, inasmuch as that would be giving an exact statement, which was precisely what the surgeon intended to avoid in giving the two possibilities. It seemed fair, however, to test the question of whether the maximum period was sufficiently long to reasonably cover the actual disabilities which occurred.

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The following table presents the figures assembled upon this subject for the large plant investigated, by departments and by years:

ESTIMATED AND ACTUAL DURATION OF DISABILITIES IN PLANT INVESTIGATED, BY DEPARTMENTS AND BY YEARS, 1905 TO 1910.

Departments and years.	Estimates of surgeons.			Actual disabilities.			
	Cases for which estimates were made.	Days lost.		Number of injuries for which—		Days lost.	
		Aggregate.	Average per case.	Days absent were not reported.	Days absent were reported.	Aggregate.	Average per injury reported.
Departments:							
Blast furnaces	1,183	23,436	19.8	79	1,625	32,467	20.0
Bessemer steel works	368	7,847	21.3	38	517	11,254	21.8
Open-hearth steel works	614	12,400	20.2	39	840	18,553	22.1
Rolling mills	1,316	25,926	19.7	104	1,772	33,941	19.2
Mechanical	624	11,391	18.3	32	1,002	15,639	15.6
Yards	574	10,537	18.4	49	845	15,217	18.0
Miscellaneous	470	10,069	21.4	31	656	14,208	21.7
Total	5,149	101,606	19.7	372	7,257	141,279	19.5
Years:							
1905	1,037	17,864	17.2	69	1,833	25,556	13.9
1906	986	20,177	20.5	107	1,460	29,217	20.0
1907	997	22,276	22.3	93	1,316	31,074	23.6
1908	561	11,989	21.4	18	655	15,091	23.0
1909	755	14,364	19.0	61	1,009	19,505	19.3
1910	813	14,936	18.4	24	984	20,836	21.2
Total	5,149	101,606	19.7	372	7,257	141,279	19.5

Inspection will show at once that the actual average duration of disability was in many cases in excess of the maximum estimates of the surgeons. The final result, showing an estimate of 19.7 days per injury, as compared with an actual average of 19.5 days, probably fairly represents the degree of accuracy with which these surgeons judged their cases.

ACCIDENTS IN NONOCCUPATIONAL GROUPS.

THE USE OF RATES IN NONOCCUPATIONAL GROUPS.

The groups for which rates have hitherto been presented have been occupational, such as steel-mill workers, blast-furnace workers, switchmen, etc. It is desirable to consider the frequency of accident occurrence where the grouping is upon some nonoccupational basis, such as by age or race. In doing so it is necessary to emphasize a difference which exists between the kinds of information derivable from rate tables in the two cases.

From occupational rate tables two items of information are directly derivable: (1) They show the relative frequency of accidents in the different occupational groups, (2) they give an idea of the relative hazards. The first point is so evident that no comment is necessary. The second needs some elaboration. When it is stated that blast furnaces have a

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certain rate and steel works another rate, the inference is at once drawn that these departments have degrees of danger in some measure corresponding with the rates. To be a worker in either of these departments is to encounter such hazards.

From nonoccupational groups nothing but frequency of accident occurrence can be directly determined. The cause of a blast furnace worker's danger is working in a blast furnace. It is entirely improper to conclude that because Polish workers, for example, show a high rate their nationality is the determining factor in that rate.

Much confusion may arise, indeed has arisen, from failure to recognize the difference in the kind of information afforded by rates in the two groups. Nonoccupational rates have been treated as though they furnished the same information as occupational rates. This may be illustrated by some ideas which have been entertained regarding the relative hazard of men and women. When rates are computed for these two nonoccupational groups men almost invariably show a higher rate. For explanation, the nature of the occupations must be considered. Quite often, however, it has been sought in some qualities of the workers and such conclusions drawn as that men are more reckless than women and therefore have a higher rate. This may be true, but the rate tables afford no foundation for the conclusion.

In order to compare the hazards of these nonoccupational groups it is necessary either fully to discuss the nature of their different occupations or to choose the groups in such a way that the danger in the groups compared shall be of the same character.[1] In this discussion groups of men and women were considered who were known to be engaged in the same work. This being the case, conclusions regarding frequency and danger could be directly drawn from the tables.

The fundamental factor in the danger of any workman is the nature of his occupation. Unless this is disclosed no conclusion regarding causes is warranted. An adequate disclosure of occupation in the table itself for nonoccupational groups is impossible. This must be done, if at all, in the accompanying text.

To avoid as far as possible the misconstruction indicated above the tables which follow regarding nonoccupational groups are cast in a different form from that used in the occupational groups. The fact that they deal with frequency only is emphasized in the headings of the tables and the rates per 1,000 employees are not presented directly, but are transformed into relative rates.

[1] Cf. Woman and Child Wage Earners in the United States: Vol. XI, Employment of Women in the Metal Trades, p. 86.

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These relative rates are determined in the following manner and are not comparable outside the table in which they occur. For convenience and uniformity the largest rate in the total for the period is chosen as the base and regarded as 100. The other rates are reduced to their proper relation to this base. Such an arrangement preserves and makes easily apprehended the relation of frequency both between the groups and the successive years.

On the basis of such presentations a number of interesting questions can be discussed and at the same time the distinction above pointed out can be kept sufficiently prominent.

AGE.

The data secured by the employment bureau of this plant makes it possible to determine the distribution by age of the working force for five of the six years under consideration. This is shown in the table which follows:

FREQUENCY OF ACCIDENT OCCURRENCE ACCORDING TO AGE GROUPS, BY YEARS, 1906 TO 1910.

NUMBER OF INJURIES.

Age groups.	1906	1907	1908	1909	1910	Total.
Under 20 years	52	56	8	30	27	173
20 to 29 years	760	694	364	577	527	2,922
30 to 39 years	382	274	183	304	298	1,541
40 years and over	156	170	89	143	115	673
Not reported	256	140	41	30	53	520
Total	1,606	1,434	685	1,084	1,020	5,829

PER CENT IN EACH AGE GROUP.

Under 20 years	3.2	3.9	1.2	2.8	2.6	3.0
20 to 29 years	47.3	48.4	53.1	53.2	51.7	50.1
30 to 39 years	23.8	26.1	26.7	28.0	29.2	26.4
40 years and over	9.7	11.9	13.0	13.2	11.3	11.5
Not reported	15.9	9.8	6.0	2.8	5.2	8.9
Total	100.0	100.0	100.0	100.0	100.0	100.0

NUMBER OF 300-DAY WORKERS.

Under 20 years	475	384	198	261	390	1,708
20 to 29 years	3,875	3,810	2,214	3,343	3,264	16,506
30 to 39 years	2,047	2,256	1,242	1,697	2,271	9,513
40 years and over	1,097	1,135	921	914	1,717	5,784
Total	7,494	7,585	4,575	6,215	7,642	33,511

RELATIVE ACCIDENT RATES.

[Based on actual rates per 1,000 300-day workers. Highest age group rate for whole period = 100.]

Under 20 years	62	82	23	65	39	57
20 to 29 years	111	103	93	98	91	100
30 to 39 years	85	94	83	101	74	92
40 years and over	80	85	55	88	38	66

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Throughout the period of five years which is here considered, except in the year 1909, the age group 20 to 29 has the highest relative rate. The relative rates for this group are as follows:

Year:	Relative accident rate.
1906	111
1907	103
1908	93
1909	98
1910	91

The groups follow in this order—30 to 39, 40 and over, and under 20. In order to explain the relations shown by these relative rates it is necessary to consider the occupational status of each of these groups. The group under 20 is that engaged in the least hazardous work. Most of those who belong to it have not yet been introduced into the more hazardous occupations. Those of 40 and over have to a certain degree passed out of the danger zone. Many of them who have passed but little over the boundary line are still to be found in the dangerous occupations and probably on this account the relative rate is higher than that for those under 20. The differences which exist in their work are so considerable that it is impossible to judge whether the factor of age is at all a significant one. If the groups could be placed under nearly identical occupational conditions, we might find the relative rates much changed, or even reversed. It is evident that some of the qualities pertaining to each of these ages would tend to raise their accident rates. Which group would be more affected by these factors it is entirely impossible to say.

The two age groups, 20 to 29 and 30 to 39, include by far the larger proportion of the steel workers. From statistics showing the age distribution in the various departments[1] and from careful observation the dangers to men in the older age group appear to be as great as those encountered by the younger. In fact inquiry shows that those who are particularly exposed to the special hazards, such as arise in the moving of molten metal, have very commonly reached their present position by a prolonged apprenticeship and are very apt to be men above 30. It is a reasonable conclusion therefore that danger in the younger age group is not greater than in the older. It appears that 20 to 29 has the higher relative rate in each year except one, and that for the whole period the number is decidedly higher for this group. It becomes, then, appropriate to inquire the reason for this higher relative rate, since apparently it can not be attributed to more dangerous occupations. The probable causes may be summed up as inexperience and immaturity. It will be seen a little later[2] that the stream of immigration which largely furnishes the working force for the steel mills is most

[1] See Conditions of Employment in the Iron and Steel Industry, Vol. III of this report, p. 99.
[2] See pp. 162 and 163.

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largely young men between 20 and 30. Such immigrant youth as come under the age of 20 do not as a rule get into the steel mills. It would appear that the places open to persons of that age are almost entirely monopolized by the American born. If the immigrant does not at once upon his arrival find his way into a steel mill he is not likely to do so at a later period. This decade, 20 to 29, is then the great recruiting period for the steel industry. Those of the group 30 to 39 are relatively experienced men who entered the works earlier or, in the rare instances where they are recently arrived immigrants, they have a degree of maturity which is not true of those between 20 and 29. The great factor is undoubtedly that of inexperience. These young men come directly from an agricultural life and are exposed upon their entrance into the activities of the steel mill to all the dangers which inevitably beset beginners.

RACE.

It is evident from what has just been said that the newly-arriving immigrants being largely of the age group 20 to 29, and being as shown, beginners in the industry, the effect of this condition will project itself into any consideration of the facts with regard to nationality. In order that the factor of age may have its proper weight, it is necessary to show the relation of the nationalities to the age groups. The following table embodies the facts determined by the Immigration Commission for the iron and steel industry of the country:

RACE AND AGE GROUPS OF EMPLOYEES IN THE IRON AND STEEL INDUSTRY.

[From Reports of the Immigration Commission, Immigrants in Industries, Part 2: Iron and Steel Manufacturing, Vol. II, pp. 335–337.]

NUMBER OF EMPLOYEES.

Race.	Employees in each specified age group.				
	Under 20.	20 to 29.	30 to 44.	45 and over.	Total.
American	4,713	14,376	12,250	5,070	36,409
German	97	1,044	1,758	1,527	4,426
Irish	16	429	1,112	891	2,448
Polish	179	4,056	3,036	626	7,897
Scandinavian	10	339	556	268	1,173
Southeastern Europeans[1]	968	10,207	8,177	1,200	20,552
Races not specified	652	5,674	4,985	1,873	13,184
Total	6,635	36,125	31,874	11,455	86,089

PER CENT IN EACH AGE GROUP.

American	12.9	39.5	33.7	13.9	100.0
German	2.2	23.6	39.7	34.5	100.0
Irish	.6	17.5	45.4	36.4	100.0
Polish	2.3	51.4	38.4	7.9	100.0
Scandinavian	.9	28.9	47.4	22.8	100.0
Southeastern Europeans[1]	4.7	49.7	39.8	5.8	100.0
Races not specified	4.9	43.0	37.8	14.2	100.0
Total	7.7	42.0	37.0	13.3	100.0

[1] Austrian, Croatian, Lithuanian, Magyar, Slovak, and Slovenian.

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The age groups used by the Commission are not the same as those employed in the plant under consideration. Under 20 and from 20 to 29 are directly comparable, but the Immigration Commission groups those from 30 to 44 and 45 and over. The table shows that the American born exceed all the others, the southeastern Europeans, Polish, Germans, and Irish coming in order. Of these the Germans and the Irish are relatively very small groups.

The second section of the table shows the age distribution of the different races. In the group under 20 the American born have a larger proportion than any other race, although their largest percentages occur in the groups 20 to 29 and 30 to 44. The southeastern Europeans and the Polish are most numerous in the group 20 to 29. The Germans, the Irish, and the Scandinavians are most numerous in the group 30 to 44. In the special plant for which data are available some variation is found from the conditions shown in the report of the Immigration Commission. In the industry at large the American born are in the ascendant over any other single group. The following table shows that in the plant under consideration the Polish race is in excess of all others, the American born coming next, and southeastern Europeans third:

RACE AND AGE GROUPS OF EMPLOYEES IN THE PLANT INVESTIGATED, FOR 5-YEAR PERIOD, 1906 to 1910.

NUMBER OF EMPLOYEES.

Race.	Employees in each specified age group.				Total.
	Under 20.	20 to 29.	30 to 39.	40 and over.	
American	1,675	4,403	1,941	1,108	9,127
German	35	472	600	748	1,855
Irish	15	312	382	459	1,168
Polish	134	8,633	4,855	2,353	15,975
Scandinavian	50	889	760	771	2,470
Southeastern Europeans	33	3,017	1,506	575	5,131
Races not specified	18	2,129	1,349	904	4,400
Total	1,960	19,855	11,393	6,918	40,126

PER CENT IN EACH AGE GROUP.

American	18.4	48.1	21.3	12.1	100.0
German	1.9	25.4	32.3	40.3	100.0
Irish	1.3	26.7	32.7	39.3	100.0
Polish	.8	54.0	30.4	14.7	100.0
Scandinavian	2.0	36.0	30.8	31.2	100.0
Southeastern Europeans	.8	58.8	29.4	11.2	100.0
Races not specified	.4	48.1	30.7	20.6	100.0
Total	4.9	49.4	28.4	17.2	100.0

The Polish and the southeastern Europeans taken together are over twice as numerous as the American born. Notice now the age distribution of those races. The American born are found to have a larger percentage (18.4) in the group under 20 than any other race.

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The highest percentage of American born is in the group 20 to 29, and the lowest in the group 40 and over; the highest percentage of southeastern Europeans is in the group 20 to 29, and of the Polish and the Scandinavians in the same group; that is, these four race groups are being recruited by newcomers belonging to the age group 20 to 29, while the American born are entering the establishments in very considerable numbers at an age under 20. This fact of the entrance of a considerable number of American born under 20 is somewhat significant. They come to the works at the age of from 16 to 18 and have as a rule a fair common school education. A study of the working force shows that it is this group who have in later years, out of proportion to their numbers, recruited foremen and gang bosses; that is, these American-born men have a decided advantage over the incoming immigrant in the matter of the places which they are likely to attain.

This table presents the situation with regard to the German and Irish in the industry in a striking way. An insignificant percentage of them appear in the group under 20. It is of course possible that members of these races are to be found in the group calling themselves Americans. This, to whatever extent it may be true, would lessen the significance of the small percentage in the under-20 age group. More significant, however, is the fact that both have their highest percentage in the group 40 and over. This certainly indicates that new immigrants of these races are not entering the industry in sufficient numbers to maintain their numerical standing. Two causes seem to be at work. First, a gradual decreased immigration, and, second, those immigrants who come from these countries are probably largely able, through the help of their already established friends, to secure at once industrial opportunities more satisfactory than those of the steel mills.

In the following table injuries suffered in the plant investigated are shown by years and races:

FREQUENCY OF ACCIDENT OCCURRENCES, BY RACES AND YEARS, 1906 TO 1910.

NUMBER OF INJURIES.

Races.	1906	1907	1908	1909	1910	Total.
American	201	195	100	141	124	761
German	42	52	38	37	32	201
Irish	43	53	22	33	23	174
Polish	644	567	269	497	472	2,449
Scandinavian	56	50	34	40	28	208
Southeastern Europeans	359	333	161	222	191	1,266
Other races	52	78	28	50	48	256
Not reported	209	106	33	64	102	514
Total	1,606	1,434	685	1,084	1,020	5,829

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FREQUENCY OF ACCIDENT OCCURRENCES, BY RACES AND YEARS, 1906 TO 1910—Con.

PER CENT OF INJURIES, BY RACES.

Races.	1906	1907	1908	1909	1910	Total.
American	12.5	13.6	14.6	13.0	12.2	13.1
German	2.6	3.6	5.5	3.4	3.1	3.4
Irish	2.7	3.7	3.2	3.0	2.3	3.0
Polish	40.1	39.5	39.3	45.8	46.3	42.0
Scandinavian	3.5	3.5	5.0	3.7	2.7	3.6
Southeastern Europeans	22.4	23.2	23.5	20.5	18.7	21.7
Other races	3.2	5.4	4.1	4.6	4.7	4.4
Not reported	13.0	7.4	4.8	5.9	10.0	8.8
Total	100.0	100.0	100.0	100.0	100.0	100.0

NUMBER OF 300-DAY WORKERS.

American	1,370	1,719	1,188	1,453	1,843	7,573
German	409	386	219	254	286	1,554
Irish	220	201	149	149	260	979
Polish	2,850	2,985	1,733	2,541	3,240	13,349
Scandinavian	513	490	333	347	389	2,062
Southeastern Europeans	1,203	809	448	919	899	4,278
Other races	929	1,005	505	552	725	3,716
Total	7,494	7,585	4,575	6,215	7,642	33,511

RELATIVE ACCIDENT RATES.

[Based on actual rates per 1000 300-day workers. Highest race group rate for whole period=100.]

American	50	38	28	33	23	34
German	35	46	59	49	38	44
Irish	66	89	50	75	30	60
Polish	76	64	52	66	49	62
Scandinavian	37	35	35	39	24	34
Southeastern Europeans	101	139	121	82	72	100
Other races	19	26	19	31	48	23

The table shows that the largest number of injuries were suffered in each of the years by the Poles and the southeastern Europeans. A comparison of numbers is, of course, inconclusive. In the fourth section of the table, therefore, the relative accident rates for these years are presented and these two groups are found to have considerably the higher relative rates. It is noticeable that the American born have a lower relative rate in each year and that the change which has occurred as a result of the safety movement is much more pronounced among them than in either of the other groups. In 1906 the relative rate for the American born was 50; in 1910 it was 23. The southeastern Europeans in 1906 had a relative rate of 101. Their relative rate in the year of special activity, 1907, was 139, and in 1910 it was 72. The Poles, belonging to an older immigrant group, make a better showing, 76 in 1906 and 49 in 1910. These figures suggest, since their occupations are closely similar, that the two groups of Polish and southeastern Europeans have a racial difference affecting their accident rates. This difference, however, must not be insisted upon too strongly. The Polish group represents on the whole a greater experience in the steel industry. They do not show a very marked preponderance in the older age group, but it is

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still true that their collective experience is definitely greater than that of the southeastern Europeans.

The low relative rate for the American born is undoubtedly due to several causes. First, a considerable number of them are in the age group under 20 and are in occupations whose hazard is relatively small. This group is not, however, of sufficient size to have a very great determining effect. Second, as has already been noticed, on advancing into the higher age groups some of the American born assume positions of supervision with somewhat lessened hazard. Third, a large proportion of them are skilled mechanics, engaged in occupations whose danger is much less than that of the blast furnaces and steel works where the foreign born are largely employed.

The higher relative rates of the foreign element in the working force can not, therefore, be understood to be largely the result of the racial qualities of the men. They are probably due much more to their lack of experience and the kind of work which naturally falls to their lot.

ENGLISH SPEAKING AND NONENGLISH SPEAKING WORKERS.

The relation of race to the occurrence of accidents, as just presented, is of interest and importance. A much more satisfactory estimate of the conditions will be possible from a consideration of the changes in the workmen's status which will occur by the time he has acquired the ability to speak English. It is evident that simply the acquisition of this ability, with its increased facility in communicating with his superiors and his fellow workmen, will have a very considerable influence. More than this, during the interval in which he has acquired the language he will in most cases have become an experienced workman. He will have developed not only in his capacity to communicate, but in all those items of knowledge which contribute to the safety of the workmen in a given employment. It has been seen that in his condition of the newly arrived and inexperienced man his situation in reference to accident is much less satisfactory than that of his American-born associates. It is desirable, therefore, to discover how far he approximates to the situation shown for the American born by the acquisition of the various elements which are associated with becoming familiar with the language. In this connection the caution should be repeated that too much stress must not be laid upon a single factor, such as inability to speak English.

The two tables which follow deal with the data necessary to the discussion of this question. The first of them shows the number and percentage of those speaking and those not speaking English, by races and by years. The Polish and the southeastern Europeans lead very

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markedly in the proportion among them who are unable to speak the English language.

EMPLOYEES IN THE PLANT INVESTIGATED WHO SPEAK AND WHO DO NOT SPEAK ENGLISH, BY RACES AND BY YEARS, 1906 TO 1910.

NUMBER OF EMPLOYEES.

Races.	1906		1907		1908		1909		1910		Total.	
	Yes.	No.	Yes.	No.	Yes.	No.	Yes.	No.	Yes.	No.	Yes.	No.
American	1,531	.....	1,843	.....	1,645	.....	2,089	.....	2,019	.....	9,127	.....
German	328	129	397	17	292	11	343	25	304	9	1,664	191
Irish	245	.....	216	.....	206	.....	216	.....	285	.....	1,168	.....
Polish	571	2,612	704	2,498	809	1,588	1,012	2,635	1,422	2,124	4,518	11,457
Scandinavian	494	79	501	14	452	8	457	39	400	26	2,304	166
Southeastern Europeans	172	1,170	160	708	171	449	406	913	386	596	1,295	3,836
Races not specified	316	721	454	624	357	342	495	298	493	300	2,115	2,285
Total	3,657	4,711	4,275	3,861	3,932	2,398	5,018	3,910	5,309	3,055	22,191	17,935

PER CENT OF EACH RACE WHO CAN AND WHO CAN NOT SPEAK ENGLISH.

American	100.0	.....	100.0	.....	100.0	.....	100.0	.....	100.0	.....	100.0	.....
German	71.8	28.2	95.9	4.1	95.9	4.1	93.2	6.8	97.1	2.9	89.7	10.3
Irish	100.0	.....	100.0	.....	100.0	.....	100.0	.....	100.0	.....	100.0	.....
Polish	17.9	82.1	22.0	78.0	33.8	66.2	27.7	72.3	40.1	59.9	28.3	71.7
Scandinavian	82.2	13.8	97.3	2.9	98.3	1.7	92.1	7.9	98.9	1.1	93.3	6.7
Southeastern Europeans	12.8	87.2	18.4	81.6	27.6	72.4	30.8	69.2	39.3	66.7	25.2	74.8
Races not specified	30.5	69.5	42.1	57.9	51.1	48.9	62.4	37.6	62.2	37.8	48.1	51.9
Total	43.7	56.3	52.5	47.5	62.1	37.9	56.2	43.8	63.5	36.5	55.3	44.7

The table discloses the fact that in the years under consideration a very considerable change has occurred in the character of the working force. In 1906, 43.7 per cent could speak English, while 56.3 per cent could not. By 1910 this had changed so that 63.5 per cent spoke the language and 36.5 per cent could not. Entirely independent of its influence upon the probable experience of the men concerned, it is evident that this increase in the number able to speak English would greatly facilitate the efforts which have been put forth in the plant toward the reduction of accidents.

The following table presents the relative accident rates for three groups, the Amerian born, the English-speaking foreign born, and the non-English-speaking foreign born:

FREQUENCY OF ACCIDENT OCCURRENCE AMONG AMERICAN BORN, ENGLISH-SPEAKING FOREIGN BORN, AND NONENGLISH-SPEAKING FOREIGN BORN, IN THE PLANT INVESTIGATED, 1906 TO 1910.

NUMBER OF 300-DAY WORKERS.

Groups.	1906	1907	1908	1909	1910	Total.
American born	1,370	1,719	1,188	1,453	1,843	7,573
English-speaking foreign born	1,906	2,267	1,689	2,027	3,283	11,172
Non-English-speaking foreign born	4,218	3,599	1,698	2,735	2,516	14,766
Total	7,494	7,585	4,575	6,215	7,642	33,511

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FREQUENCY OF ACCIDENT OCCURRENCE AMONG AMERICAN BORN, ENGLISH-SPEAKING FOREIGN BORN, AND NONENGLISH-SPEAKING FOREIGN BORN, IN THE PLANT INVESTIGATED, 1906 TO 1910—Concluded.

NUMBER OF INJURIES.

Groups.	1906	1907	1908	1909	1910	Total.
American born	201	195	100	141	124	761
English-speaking foreign born	235	381	168	264	165	1,213
Non-English-speaking foreign born	1,026	771	326	559	591	3,273
Not reported	144	87	91	120	140	582
Total	1,606	1,434	685	1,084	1,020	5,829

RELATIVE ACCIDENT RATES.

[Based on actual rates per 1000 300-day workers. Highest group rate for whole period=100.]

American born	66	51	38	44	30	45
English-speaking foreign born	56	64	45	59	23	49
Non-English-speaking foreign born	110	197	87	92	106	100

In both groups of English-speaking workmen the relative rates decline markedly in these years. In the non-English speaking the relative rate in 1910 is almost as high as in 1906. It would appear that as the foreign-born workman acquires the language and the experience of the work which must accompany that acquisition he approaches the situation regarding frequency of accidents of his American-born fellow workman. To state the fact in another way whatever influence his race may have had is a vanishing factor.

The apparent failure of the safety movement to materially improve the condition of the non-English-speaking workmen demands further consideration and explanation. It may be said, first, that its importance is not so great as might at first appear to be the case. The English-speaking group has constantly and markedly increased, while at the same time its relative accident rate has declined. The result of this is that the improvement applies to an increasingly greater proportion of the working force from year to year and conversely the group which shows little or no improvement has been relatively declining. When the kind of work in which these who are unable to speak English are engaged is noted it will be found that they are the occupations in which the greatest difficulty exists in introducing safety methods. Into these occupations the inexperienced foreigners are constantly coming. They are the most unstable and shifting occupations. In them are combined all the conditions which are favorable to frequent accident occurrence. It would appear that the efforts thus far put forth have been inadequate to meet this situation.

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The following table from another plant gives some light upon the departments in which inexperienced foreigners are most largely employed: In the steelworks and in the yards are found the highest percentage of non-English speaking. In the steelworks the natural dangers of occupation have been shown to be serious. The yards are less dangerous but have not improved as much as other departments. The bringing together of serious danger and inexperienced men results in frequent accidents.

Since in the nature of the case these two departments must continue to employ the largest proportion of those without experience, it is obvious that they demand the most earnest attention with a view to lessening their dangers.

ENGLISH-SPEAKING AND NONENGLISH-SPEAKING EMPLOYEES IN A CERTAIN PLANT, BY DEPARTMENTS.

Departments.	Number who speak English.	Number who do not speak English.	Total.	Per cent who speak English.	Per cent who do not speak English.
Blast furnaces	625	74	699	89	11
Open hearth	923	238	1,161	80	20
Rolling mills	1,294	182	1,476	88	12
Mechanical	1,031	54	1,085	95	5
Yard	843	166	1,009	84	16
Total	4,716	714	5,430	87	13

CONJUGAL CONDITION.

A question frequently raised is whether there is a difference, which appears in the frequency of accident occurrence, between the men who have dependent wives and children and those who do not. The natural supposition is that the possession of such dependents would lead to the exercise of greater care and caution and that accordingly the relative accident rate of the married might be lower than that of the unmarried. It was possible, as shown in the following table, to divide the working force for five years upon this basis and to determine relative rates for each of the two groups. In three of the five years the group of married workmen shows a higher relative rate than the single, but for the whole period the difference between the relative rates, 100 for the married and 92 for the single, is not great enough to serve as a basis for positive conclusions. It may be added that in order to secure a degree of uniformity of occupation as complete as possible these figures pertain to the age group 30 to 39.

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FREQUENCY OF ACCIDENT OCCURRENCE ACCORDING TO CONJUGAL CONDITION, IN AGE GROUP 30 TO 39, IN PLANT INVESTIGATED, 1906 TO 1910.

NUMBER OF 300-DAY WORKERS.

Conjugal condition.	1906	1907	1908	1909	1910	Total.
Married	1,590	1,827	882	1,350	1,895	7,544
Single	457	429	360	347	376	1,969
Total	2,047	2,256	1,242	1,697	2,271	9,513

NUMBER OF INJURIES.

Married	299	288	149	224	235	1,195
Single	76	80	31	60	41	288
Not reported	7	6	3	20	22	58
Total	382	374	183	304	298	1,541

RELATIVE ACCIDENT RATES FOR MARRIED AND SINGLE WORKERS.

[Based on actual rates per 1000 300-day workers. Highest group rate for whole period=100.]

Married	119	99	109	105	78	100
Single	105	118	54	109	69	92

SAFETY ACTIVITY AND PRODUCTION.

When a prominent director of safety addressed an audience of Cleveland manufacturers, exhibiting to them the safety devices in use in the establishment with which he was connected, the first question asked by one of the manufacturers was "Can you have all these things and do any work?" That question has been in the minds of many who otherwise would be interested in the safety movement, with a very strong tendency to a negative answer; that is, many men have sincerely believed that the safety device as urged by those whom they were inclined to regard as mere theorists would be a very serious handicap upon production. For a concrete answer to these questions two tables and two diagrams have been prepared, showing the relative accident rates and the relative production, in a Bessemer steel works for the years 1905 to 1910 and in the plant investigated for the years 1900 to 1910:

RELATIVE ACCIDENT RATES AND PRODUCTION IN A BESSEMER STEELWORKS, BY YEARS, 1905 TO 1910.

Years.	Number of 300-day workers.	Tons produced.	Tons per 300-day worker.	Relative production (1905=100).	Accident rate per 1,000 300-day workers.	Relative accident rates (1905=100).
1905	352	916,086	2,603	100	429	100
1906	369	903,082	2,447	94	236	55
1907	385	961,967	2,499	96	232	54
1908	228	550,550	2,415	93	202	47
1909	250	746,225	2,985	115	208	48
1910	349	846,929	2,574	99	212	49

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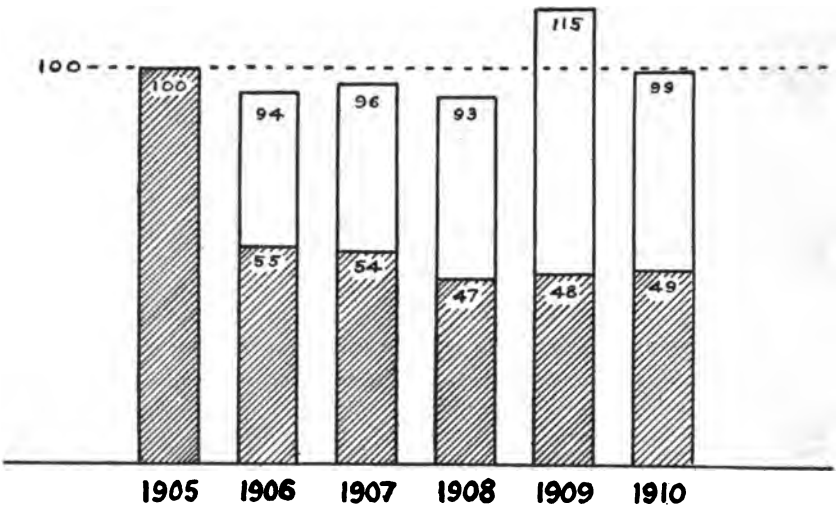
RELATIVE ACCIDENT RATES AND PRODUCTION IN A BESSEMER STEELWORKS, BY YEARS, 1905 TO 1910.

[1905=100 in each case.]



RELATIVE ACCIDENT RATES AND RELATIVE PRODUCTION IN PLANT INVESTIGATED BY YEARS, 1900 TO 1910.

[1900=100.]

Years.	Number 300-day workers.	Relative accident rates.	Relative production.
1900	5,045	100	100
1901	5,265	95	111
1902	5,137	92	125
1903	5,119	95	119
1904	5,296	89	100
1905	6,406	81	113
1906	7,494	58	110
1907	7,585	51	121
1908	4,575	41	112
1909	6,215	47	148
1910	7,642	36	118

The first table and the diagram which follows it relate to the Bessemer steel works. It is already apparent that steel works of this type have the greatest hazard of any of the departments of a steel plant. Taking the year 1905 as 100, both in the accident rate and in the production in the Bessemer mill, the results of the recent years are plainly shown. With the beginning of special safety activity the accident rate declined very markedly, then declined more gradually for two years and has remained practically stationary since that time.

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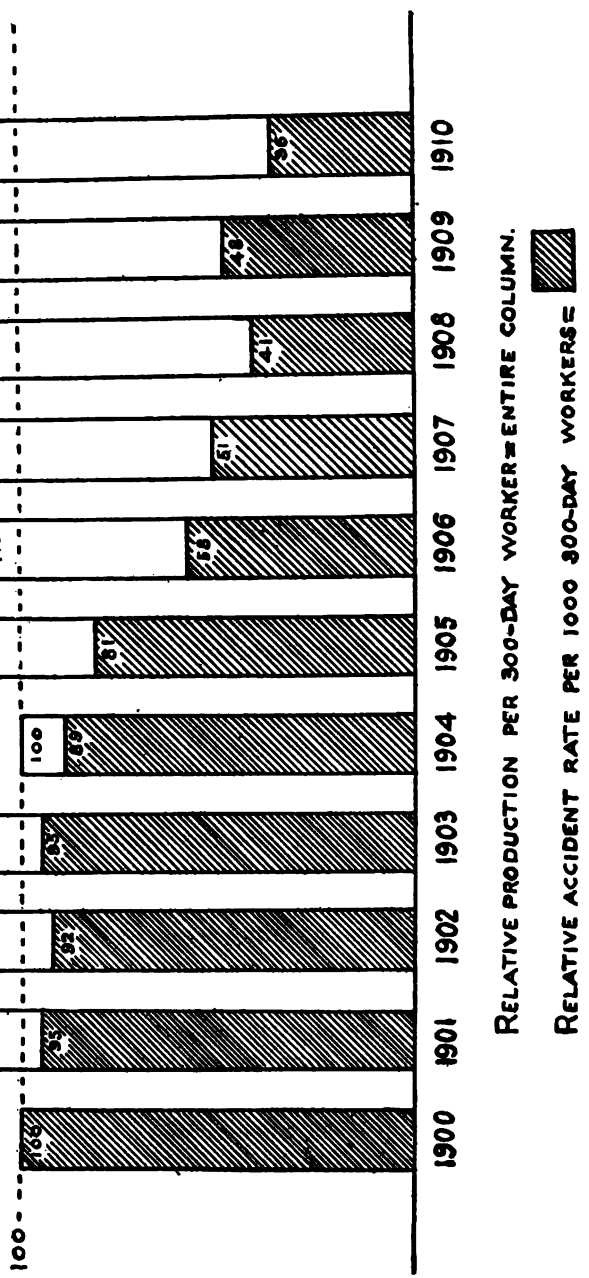
RELATIVE ACCIDENT RATES AND PRODUCTION IN LARGE STEEL PLANT INVESTIGATED, BY YEARS, 1900 TO 1910.



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Meanwhile the average production of the five years in which safety activity has been going on is but slightly less than that of the year 1905.

It is evident that in an extremely hazardous department, where the difficulties of safeguarding are very great and where the necessary precautions would be likely in some respects to hamper output, no such result has occurred. The second table, with the accompanying diagram, discloses the condition in this particular for the plant as a whole. The diagram shows that during a period of five years a slight reduction had been made in the accident rates, the production fluctuating but constantly exceeding the production of 1900, which is here taken as a basis. Beginning with 1905 there is a rapid reduction of accident rates to the year 1910. During the six years in which this reduction occurred the average production was materially in excess of the preceding five years. Similar studies made of each mill in the plant show accordant results. These years of marked accident reduction have not been years of reduced output but have uniformly been years in which output has been satisfactorily maintained.

RESPONSIBILITY FOR ACCIDENTS.

The assignment of the responsibility for accidents is largely a matter of judgment. Such judgments have too often been presented as though they were facts. Frequently it has been assumed that some personal responsibility attaches to every accident; classes have been established on this basis, and each occurrence assigned its place in the classification. When other possibilities of this fixed classification were exhausted, all remaining cases were assigned to the group of "workers' negligence." The argument often advanced for such treatment of a case has been that "if the worker had not been negligent the accident could not have happened, therefore he must have been careless."

This tendency has at times gone to lengths as absurd as they are seriously unjust. For example, in the records of a mill which assigned 95 per cent of accidents to "workers' negligence" the following case was found: An electric lamp globe, suspended at a considerable height, broke from some cause, and the falling fragments severely cut a young woman passing below, and she was charged upon the records with "ordinary negligence." The implication clearly was that with due care the girl in question would have divined the coming downfall and kept out of the way. The serious side of such records is that they have been published under the sanction of high authority and are quoted as significant.

It seems important that judgments which are so liable to error should not further be presented as established statistical facts, and

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for this reason the tabular form is not used in presenting the results of the study.

Since the items to be presented rest upon the judgment of the investigator, it is desirable to present in some detail the method of procedure.

The records consulted were: (1) A formal statement upon a specified blank form from the foreman under whom the injured man was at work, and (2) the hospital records, which frequently contained a statement from the man himself regarding the circumstances of the accident. The comparison of these two was very important, since in case of disagreement it was possible to make further inquiries. Besides these sources of information in every case which had given rise to legal proceeding the complete papers were on file. A reading of these gave information regarding the kinds of negligence charged against the employer and the view taken by counsel, judges, and juries in each case which reached various stages of litigation.

For recent years there are on file with the records of serious accidents the findings of the joint investigation conducted by the safety office and the permanent committee of foremen for the department in which the accident occurred. A most satisfactory basis for judgment is furnished by the body of records under discussion, and in addition it was possible to investigate directly in the works many of the recent cases.

For present purposes five classes are presented in this discussion. These are: (1) Hazard of industry, (2) negligence of worker, (3) negligence of fellow worker, (4) negligence of employer, and (5) not disclosed by the record.

There is at the present time a tendency to recognize much more fully than was formerly the case that many injuries are not properly chargeable to any individual or group of individuals. In many cases it is manifestly unjust to select some one person or factor as the one of such importance that it must stand out as chiefly responsible. When clearly unforeseeable and unavoidable circumstances constitute a definite and large element it appears much more reasonable to regard the occurrence as due to a hazard of the industry. Some persons take the position that this class should contain only those cases which are from our present knowledge apparently unpreventable. This view is much too narrow. It fails to recognize as a real element in the industrial situation the character of the human machine. A man is often quite unconscious of and irresponsible for certain defects in himself which endanger his own life and the lives of others.

Every hazard of industry is in a certain sense a responsibility of the employing and supervising agency. Many of the hazards appear to have no remedy. In view of the facts of the safety movement

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it can not be asserted positively that any risk is beyond remedy. Such a reduction as has occurred in accident rates in American steel mills would have been regarded as practically impossible by steel men in the country six years ago.

Hazard of industry includes, therefore, in the present classification those occurrences in which unforeseeable or unavoidable factors are a major element. It may appear that the worker has done some things which he would not have done if he were better instructed or if he were a more perfectly acting machine. These factors ought not to be unduly magnified. The worker should have the benefit of the doubt.

Negligence of workmen needs little comment. It appears with perfect clearness at times that men disobey orders, refuse to use safeguards provided, fail to do in a proper manner what they well know how to do, or take risks for the saving of a little time or labor which endanger themselves or others. These forms of negligence can be reached only by discipline, sharp, prompt, and relentless.

The cases of unquestionable neglect on the part of the employer are usually well defined. There are, however, so large a number of instances where the question is one of legal interpretation rather than one of fact that conclusions must be reached with great caution.

A total of 7,750 cases were considered, covering all disabling accidents in the plant investigated for the six years ending December 31, 1910. After each case had been carefully studied it was assigned, according to the judgment of the investigator, to one of the classes enumerated above. The results were then tabulated and the per cents for each class in the entire plant were found to be as follows: Hazard of industry, 60 per cent; negligence of worker, 7 per cent; negligence of fellow worker, 6 per cent; negligence of employer, 4 per cent; not disclosed by the record, 23 per cent. The percentage assigned to hazard of industry is distinctly higher than in other similar compilations, and this is in accord with what would naturally be expected in the steel industry, which is subject to unforeseen dangers. There may arise at any moment a combination of circumstances which could occur only at such rare intervals that to foresee and provide against them beforehand is impossible. In considerable measure this situation has contributed to a feeling of helplessness among steel men which has been interpreted as indifference. It is now known that this feeling of helplessness was entirely unwarranted.

While the high percentage ascribed to hazards of industry is not likely to be much reduced, they are not hazards without remedy. They simply inhere in the industry in its present stage of development and in the present state of our knowledge. That many of

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them should continue to exist after proper study of the situation would clearly be negligence of the employer.

The creation of the group "Not disclosed by the record" is justified both by the records and by the facts. Two causes give rise to records which fail to disclose responsibility—(1) the recording foreman does not or can not set down the data necessary to a conclusion; (2) it is impossible in the nature of the case to decide upon that point. The failure of the foremen may be due to oversight or to sheer inability to grasp and understand the facts. On the other hand, it often happens that the accident itself destroys the only evidence which could decide the question. To illustrate, a molten-metal explosion of great violence ensued upon the overturning of a ladle. The man in charge of the tilting apparatus either lost control through some defect or abandoned his post from needless panic. The mechanism was wrecked by the explosion and the man was among the fatally injured, so that no conclusion as to responsibility could be reached. This is by no means an isolated case. Repeatedly it has become evident that while responsibility for an accident should rest either on the workman or on the employer or on both, no scrutiny, however close, could make it even reasonably certain where it lay. Lawsuits have been instituted and prosecuted and verdicts rendered in which the evidence was absolutely inconclusive, and in the nature of the case must be. All of this gives added emphasis to the conclusion fast becoming universal that the effort to deal with industrial accidents on the basis of responsibility is futile and necessarily unjust.

The different departments of the plant present some points of interest justifying individual statements. The per cents of accidents of each class in the 5 principal departments were as follows:

Blast furnaces (1,749 cases): Hazard of industry, 69 per cent; negligence of worker, 6 per cent; negligence of fellow worker, 5 per cent; negligence of employer, 4 per cent; not disclosed, 16 per cent.

Steel works (1,454 cases): Hazard of industry, 69 per cent; negligence of worker, 7 per cent; negligence of fellow worker, 5 per cent; negligence of employer, 4 per cent; not disclosed, 15 per cent.

Rolling mills (1,898 cases): Hazard of industry, 52 per cent; negligence of worker, 6 per cent; negligence of fellow worker, 7 per cent; negligence of employer, 3 per cent; not disclosed, 32 per cent.

Mechanical occupations (1,048 cases): Hazard of industry, 54 per cent; negligence of worker, 9 per cent; negligence of fellow worker, 7 per cent; negligence of employer, 4 per cent; not disclosed, 26 per cent.

Yards (904 cases): Hazard of industry, 59 per cent; negligence of worker, 5 per cent; negligence of fellow worker, 5 per cent; negligence of employer, 4 per cent; not disclosed, 27 per cent.

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Greater hazard in blast furnaces and steel works is in conformity with data shown elsewhere.

PROGRESS OF THE SAFETY MOVEMENT.

In relation to the progress of the safety movement a group of figures are available, making possible the comparison of two periods of six months each in 1910 and in 1911 in the nine plants of a large company. The following table embodies the facts. In only two of the nine plants are the rates higher in the later period. In each of the others a distinct and often considerable decline is shown. These are important, since they give convincing evidence that the movement is successful, not only in particular plants but on a large scale and over a wide area.

COMPARISON OF THE NUMBER OF DISABLING INJURIES OCCURRING IN THE TWO SIX-MONTH PERIODS ENDING JUNE 30, 1910, AND JUNE 30, 1911, IN 9 PLANTS OPERATED BY ONE COMPANY.

Plant No.	Number o f300-day workers.		Number of disabling injuries, 6 months ending June 30—		Rates per 1,000 300-day workers, 6 months ending June 30—	
	1910	1911	1910	1911	1910	1911
1	6,913	6,383	630	565	91.1	85.8
2	6,037	5,388	844	592	139.8	109.9
3	2,048	1,509	246	230	120.1	152.4
4	1,048	1,000	40	45	38.1	45.0
5	1,084	1,119	76	57	70.1	50.9
6	2,037	1,254	130	50	63.8	39.9
7	192	210	13	8	67.7	38.1
8	1,749	1,178	225	99	128.6	84.0
9	229	145	19	11	82.9	75.9
Total	21,337	18,186	2,223	1,657	104.2	91.1

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CHAPTER III.

ORGANIZATION AND DEVELOPMENT OF THE SAFETY DEPARTMENT.

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CHAPTER III.

ORGANIZATION AND DEVELOPMENT OF THE SAFETY DEPARTMENT.

In a majority of the plants studied in connection with this report active efforts are made for the prevention of accidents. In connection with these efforts distinct safety departments have in many cases been created. The work of the safety departments usually consists of three well defined divisions: (1) Organization, (2) education, and (3) safeguards.

THE SAFETY ORGANIZATION.

THE INSPECTOR.

The safety organization has usually grown up in each plant around some individual, generally the safety inspector. The insurance companies have done much by their system of inspection to give direction to this movement. From the occasional visit of an insurance inspector who offered suggestion or made requirement regarding the betterment of dangerous conditions, it was an easy step to the appointment of some member of the plant force to take the responsibility. The influence of State inspection upon the situation has not been great. This has been largely due to the fact that in the area wherein the industry has mostly developed the law has not put the inspection service in a position to deal intelligently and effectively with the difficult problems presented by this industry.

The local safety inspectors have been derived from various sources, being sometimes lawyers who had served in the claims department, sometimes operative men from some mill department, and sometimes mechanical engineers. At the outset the operative men invariably regarded, and in many quarters still regard, the safety man with suspicion and even positive hostility. This was inevitable, since the creation of the safety inspector placed in a position of some authority a man whom the operative superintendents often regarded as an inferior. They felt that with his limited knowledge and experience of the technical side of the industry he was not entitled to criticize or prescribe for them. They were fully convinced that the accidents in their business, and particularly in their mill, were inseparable features of getting out an adequate tonnage.

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THE SAFETY COMMITTEE.

The only solution of this problem thus far offered has been the safety committee. While details of organization differ, this method of securing harmonious action is now very widely in use. Usually some one person will be maintained in the chairmanship, and by some system of rotation the various operative men have a term of service. Several things are thus secured. First, a sense of personal responsibility which leads to study of the situation and ultimately, in most cases, to an entire reversal of attitude. An electrical engineer, now a most enthusiastic and efficient chairman of the committee in the plant with which he is connected, was formerly in charge of the electrical installation of a very large new plant. In this work he was associated with the director of safety of the company for which the plant was being constructed. The men had some discussion over the ideas which the safety man wished incorporated in the new works. In the course of the discussion the engineer remarked that the idea of a safe steel plant held by the director of safety was "one inclosed in a glass case and operated from the outside." At the present time this engineer, after experience on the safety committee, is, if anything, more radical than the safety man.

Illustrating the fact that a feeling similar to this is still held by more than one, especially among the older superintendents, is the remark directed to the writer by a certain superintendent. He said: "I'll tell you how to make a plant like this safe. Build a high wall around and keep the men out." Then he added, "If these chaps have their way, that's what it's coming to." It must not be supposed that this was a man who had no care for the lives and limbs of his men. He was noted for constant acts of personal attention to injured men and was regarded with an unusual degree of personal affection, but he had been engrossed in the problem of making his mill productive and held the acceptance of its dangers as a proper test of manly courage. The overcoming of such prejudices and the education of the operative man in the possibilities of safety activity is the first result of the safety committees.

The chart here presented is one of a series, one for each department, prepared by a director of safety. These charts are kept on the table in the room where the superintendents meet. At the end of each month when the month's results are entered up the charts are considered in detail. This keeps each superintendent alert and informed. It has proved a very successful educational device.

Another method used in a certain plant has features which make it desirable to present. On the basis of the results attained in 1911 the superintendents and director of safety worked out a standard for 1912 which seemed the best that they could hope to reach. This

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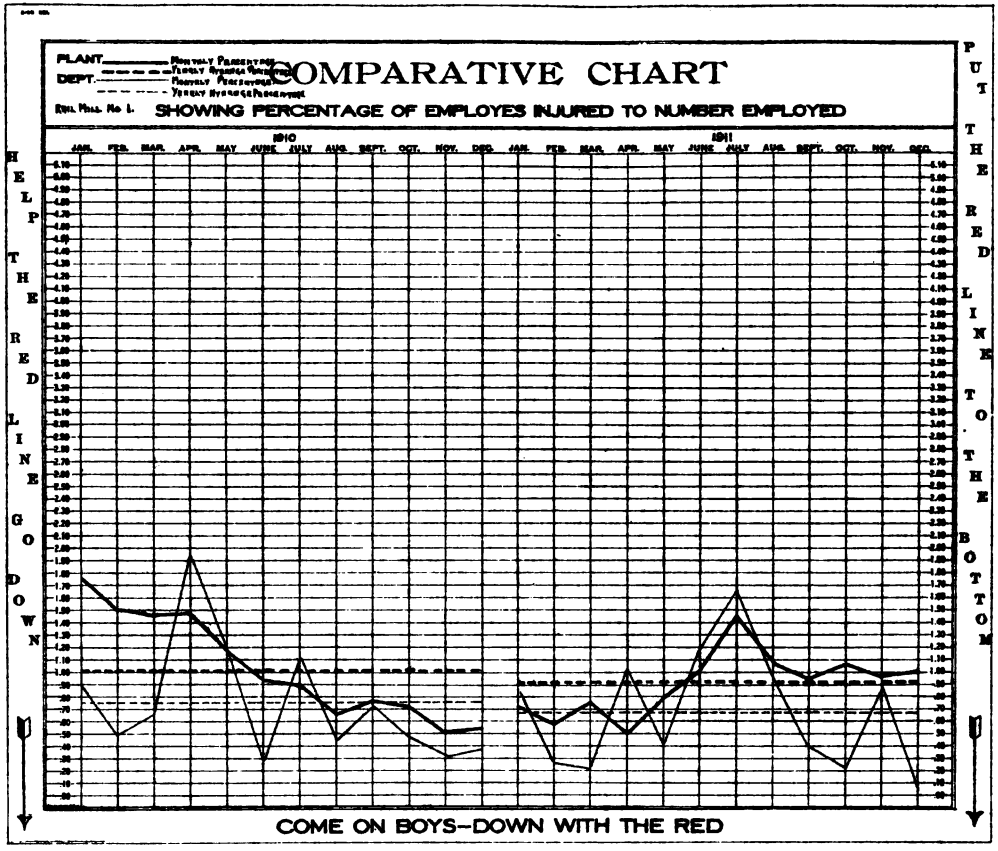
PLANT.
DEPT.
Roll Mill No 1.
COMPARATIVE CHART
SHOWING PERCENTAGE OF EMPLOYES INJURED TO NUMBER EMPLOYED
1910
1911
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
HELP THE RED LINE GO DOWN
PUT THE RED LINE TO THE BOTTOM
COME ON BOYS—DOWN WITH THE RED

THE NORRIS PETERS CO., WASHINGTON, D. C.

Senate Doc. No. 110 ; 62d Cong., 3d Sess.

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standard is expressed in per cent per month of the working force to which they attempt to reduce the accident rate. These percentages were determined both for four primary divisions of the plant and for the smaller subdivisions.

This scheme is called a "cost contest" and is used in the superintendents' meetings to indicate from month to month the results of safety effort. The statement for the month of May, 1912, is shown in the following table exactly in the form presented by the company. The table indicates the standard per cent of working force to which it is hoped to reduce the accident rate, the working force for the month and for the year to date, the number of accidents which will exactly correspond to the standard per cent, the actual accidents for the month and for the year to date, and in the final columns figures which are intended to express what is termed the "safety efficiency." The latter figures are obtained by dividing the "allowable" number of accidents by the actual number which happened. It may properly be remarked that the standard aimed at was a very high one, based upon a relatively inactive year.

COST CONTEST.

[This statement is reproduced exactly in the form presented by the company.]

CONTEST "A." **For May, 1912.**

No.	Department.	Standard.	Force.		Allowable.		Accident.		Safety efficiency.	
			Month.	Year.	Month.	Year.	Month.	Year.	Month.	Year.
1	No. 12 mill	1.501	251	1,196	3.77	17.95	2	17	188.50	105.59
2	Upper mills	.922	718	3,455	6.62	31.85	10	35	66.20	91.00
3	Steam	.516	191	951	.98	4.91	0	6	.....	81.83
4	Lower mills	1.060	482	2,324	5.11	24.63	9	32	56.78	76.97
5	Double storage mills	1.248	360	1,651	4.49	20.60	7	28	64.14	73.57
6	2 open hearth	1.197	211	1,071	2.52	12.82	4	18	63.00	71.22
7	Bloom mills	.723	559	2,756	4.04	19.92	4	29	101.00	68.69
8	No. 14 mill	1.197	249	1,160	2.98	13.88	4	26	74.50	53.38
9	Bessemer	1.370	143	713	1.96	9.77	3	19	65.33	51.42
10	1 open hearth	1.291	128	654	1.65	8.44	0	17	.....	49.65
11	Polishing mill	1.594	359	1,772	5.72	28.24	19	64	30.10	44.12
12	3 open hearth	1.388	162	808	2.25	11.21	5	26	45.00	43.12
13	Foundries	.421	280	1,409	1.18	5.93	4	15	29.50	39.53
	CONTEST "B."									
1	Rolling mills	1.138	2,234	10,593	25.42	120.55	35	146	72.63	82.57
2	Steel works	1.037	1,290	6,431	13.38	66.69	18	113	74.33	59.02
3	Power department	.390	392	1,942	1.53	7.57	1	14	153.00	54.07
4	Shops and foundries	.899	949	4,715	8.53	42.39	24	83	35.54	51.07
	Total	.922	5,601	27,288	51.64	251.59	80	376	64.55	66.91

A second result of the committee system arises from comparing safety results with those of neighboring mills. A member of such a committee has an official reason for looking into what the man in the next mill is doing. In doing this he is given an incentive to look after the condition of his own premises. The outcome is the gradual

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diffusion among the operative force of a much better general plant knowledge, an appreciative understanding of the difficulties, and oftentimes the development of important new operative ideas. As an element in producing plant solidarity a general superintendent may well undertake safety work if there were no other motive.

A third result of the committee work is to focus upon the safety problems the trained intelligence and organizing power which has accomplished the remarkable results in production which have been attained in the iron and steel industry.

Thus far in the discussion attention has been directed to plant organization. Before discussing the educational work of the safety department it is necessary to say something of interplant and intercompany committees.

In 1906 the general solicitor of the United States Steel Corporation called together the claim agents of the various subsidiary corporations and discussed with them the accident situation indicated by the reports reaching the central office. From this gathering was developed in 1908 a general safety committee. This committee consists of the general solicitor as chairman, the assistant solicitor as vice chairman, a secretary in the New York office, and a member representing each of several subsidiary companies. This committee has been an important factor in the development of the safety work in the corporation. It has issued bulletins describing and illustrating the devices which have proved satisfactory in the various companies, thus making them available not only for their own plants but for others who may wish to use them; it from time to time sends inspectors who go over the plants of the different subsidiaries and report conditions; at intervals the members of the committee jointly or severally make tours of inspection. This is the most comprehensive scheme of the kind now in operation.

Of interplant committees a good illustration is that maintained by the Illinois Steel Co. This company operates five plants in the vicinity of Chicago. Its committee consists of a chairman from the legal department, a secretary from the same department, who has immediate charge of the personal-injury cases in which suit is brought, the assistant general superintendent of each plant, and the director of safety of each plant. This committee holds monthly meetings, when all accidents of a serious character are discussed, means of prevention suggested, and plans laid for various forms of safety work. All proposed changes in safety rules are here thoroughly discussed, the presence of the operative men assuring that objections to a given rule or device from an operative standpoint will not be overlooked. The committee has published a volume of standard safety devices which has been most serviceable. This committee was among the first to require that all drawings for new equipment be made with a view to

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safety. As a result of the attitude of this and other committees machine construction has undergone a great change. Many protective devices are being incorporated in the design of machines now being manufactured.

The owner of a small plant is likely to be unaware that the accident rate in his plant is as high or higher than that in a large plant. When an employer of 500 men has one fatality in a year he is apt to regard himself as making a better record than the employer of 5,000 who has 8. Part of the reputation of the iron and steel industry for high rates is due to the fact that it operates in relatively large units and is judged by its aggregate rather than by the ratio of accidents to men employed, which is the real test. This situation is of importance, since as a result of it many small employers tend to excuse themselves from active effort along safety lines. They say of themselves "Our accidents are very few," but when viewed in a proper light of relation to numbers employed they are very many, and the need of safety effort is apparent quite as much as in the large concerns. The safety committee system can be applied to the smallest plant. Its fundamental meaning is the formal directing of attention to safety problems, and this is as possible for the man who employs a few workmen under his own eye as for the huge mill with its many subdivisions.

EDUCATIONAL WORK OF SAFETY COMMITTEES.

The educational value of committee organization upon the supervising men has already been indicated. This body has the problem of diffusing knowledge regarding prevention of accidents to those immediately in charge of the work and ultimately to the workers themselves. A large share of the accidents commonly ascribed to carelessness arises from ignorance and imperfect training. To remedy this is the great problem of the safety committee. One method of furnishing instruction is the publication and distribution of formal rules, with suitable methods for insuring that they are given definite attention. Since a large proportion of the workers in this industry do not read English, it has been necessary to issue these rules in various foreign tongues, ranging from five to eleven in different companies whose practice was noted in the course of the investigation. Merely to print these regulations and put them in the workers' hands has proved of little use, and some of these publications have been prepared so much from the standpoint of avoiding liability on the part of the company as to be of little real utility. It has been found essential in the first place to insure that foremen are familiar with the safety rules. The readiest means of so doing thus far suggested is to require each one after a reasonable time to show by examination that he has actually studied the rules. In a number of important

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plants the attainment of a certain grade in this examination is recognized by some token, usually a neat button. Gradually this system is being extended to the workmen and a group of men committed to the safety idea and informed regarding its principles is being built up. One of the successful companies displays constantly the phrase "Safety First." In connection with this form of educational effort the illuminated signs shown in the accompanying illustration (plate 1) are being used with good effect.

Another effective way of reaching the ordinary workman is by an admonition on his pay envelope. He may be unable to read English, in which language these suggestions are most often printed, but thinking it has some relation to his pay he very promptly seeks a translation. One company has installed safety bulletins throughout its works. Upon these are placed from week to week clippings from the papers regarding industrial accidents. Beside these are shown the rules of the company applying to similar cases and often a picture of the device used to prevent similar occurrences. Since these clippings were in English it appeared somewhat doubtful whether they were reaching the men who did not read that language. Repeated personal observations, however, disclosed frequent groups standing about these boards while an interpreter explained the significance of the posted matter.

A second educational method is the extension of the committee system. It was first attempted by creating departmental or foremen's committees. These are required to devote a certain amount of time each month to a searching investigation of their own department or of the entire plant, observing unsatisfactory conditions, reporting the same to the safety department, and making recommendations for their improvement. If an accident occurs within a department assigned to the committee it proceeds at once to investigate all the circumstances, particularly with a view to preventing the recurrence. The whole attitude of such an investigation is different from that made under the old conditions when the investigation was primarily to locate responsibility and particularly to disclose evidence of the workers' negligence. While a safety department may from time to time feel obliged to go into that question, it has been found that these foremen's committees are mainly concerned with preventive measures.

The organization of committees of ordinary workmen may be classed as a third educational method. This is a very difficult extension of the system. The foreman has by reaching his position demonstrated some qualities of intelligence and leadership. For the rank and file there is no such ready-made test. It is still too soon to judge of the possibilities of these workers' committees. Their positive recommendations have not been of great value and

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"THE PREVENTION OF ACCIDENTS
AND INJURIES, BY ALL POSSIBLE
MEANS, IS A PERSONAL DUTY
WHICH EVERYONE OWES,
NOT TO HIMSELF ALONE BUT
ALSO TO HIS FELLOW WORKMEN."

PLATE 1.—ILLUMINATED SIGN AT ENTRANCE TO PLANT.

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they are quite likely to expend themselves upon trivial details. Since, however, the returns in positive suggestion are the least important results to be hoped for from the workmen's committees, they deserve a careful and thorough trial.

The details of one inter-plant safety organization show department committees of foremen and committees of workmen as branches of the safety committees of each plant, these plant safety committees being in turn branches of a central safety committee. An important element here introduced is that the relations of the workmen's committees are not with their immediate superiors but with men higher up who constitute the plant safety committee. This relation does not exist in all plants where the workmen's committees are being tried.

A great factor in the condition of American mills as regards accidents has been what has been termed the dehumanizing of industry. With the development of huge units of production the responsible management has been gradually removed from contact with actual production. There has been in many cases no common ground for workmen and employers. This situation is changing as the principle of compensation forces its way into the laws and the principle of cooperation takes root in American practice. The significance of the safety movement in this connection is that if wisely and thoroughly promoted it unites the entire fabric of an industrial enterprise from top to bottom in the pursuit of a desirable end. It introduces a sympathetic note into relations much strained by the form which American industrial development has taken. It is no more a cure-all for industrial antagonisms than are other suggested remedies, but its possibilities go beyond reducing accidents, even beyond saving human life.

The subject of direct safeguarding methods here classified as the third division under the safety department is treated in detail in Chapter IV.

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CHAPTER IV.

DIRECT SAFEGUARDING METHODS.

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CHAPTER IV.

DIRECT SAFEGUARDING METHODS.

At present this is the most interesting manifestation of the safety movement, though it is not of such far-reaching importance as some other features. Historically it is the oldest form of effort toward accident reduction. Individual concerns here and there have endeavored to render their work places more secure. The fact that the best of these concerns have found it necessary to spend much thought and large sums of money in more recent efforts, in which they have really grappled with the situation, is convincing evidence of the deficiencies of the early efforts.

Safeguarding can best be presented by following in detail the procedure in each department. A general statement of the conditions involved in each case is first given, followed by a description of special devices and the discussion of specific rules.

YARD DEPARTMENT.

Throughout a steel mill the transportation problem is serious. Many of the plants began on a small scale in localities unsuited to the expansion which has taken place. A frequent result has been a tangle of tracks, broad and narrow gauge, with frequent overhead cranes of both the ordinary and the gantry type. In many cases the tracks of the railroad which serves the plant run in such relation to the mills that the avenues for the approach of workmen cross them. Viaducts and subways are being provided to remove the resulting dangers.

Once within the yards several general precautions are of importance. One superintendent has remarked that "the foundation of a safe plant is a clean plant." This applies especially to the yard where débris being out of the way of mill operations and not positively interfering with yard routine is very apt to accumulate.

Appropriate warning signs at danger points are of much use in the yards, and their display in many languages has been found desirable. Regarding these warning signs it may be said in general that they should never take the place of a positive removal of the danger. Their real significance is probably less in the direct prevention of accident than in the educational value and in presenting a constant emphasis upon the attitude of the management.

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Like all railroad yards the tracks of the mill yard present the possibility of a man having his foot caught in the frogs. The secure blocking of these is a feature of good practice. In the illustration (pl. 2) is shown at "A" a device known as the Ferguson guard. These guards are made of $\frac{5}{16}$-inch plate steel, cut, bent, and securely fastened in place, replacing the wooden blocks formerly used. In the same illustration is shown at "C" a safety gate where the tracks cross.

In the operation of switches the simplest and consequently the most frequent practice is to have the lever actuating the switch operate at right angles to the track. This exposes the switchman, especially in icy weather, to the danger of falling across the track as he operates the lever. Recent installations have the lever operated parallel with the track.

The noises of a mill yard are so many and confusing that any signaling device which produces a sound peculiar in quality or unusual in position has advantages. A bell attached to the front of a yard locomotive near the track furnishes an example of a device of this kind. The bell may be operated by hand or automatically by steam.

In plate 3 is shown a turntable to the girder of which is attached a circular handrail. This rail revolves with the turntable and prevents men from walking into the pit at night.

When a track passes near the corner of a building it may easily happen that anyone passing upon the track will do so without observing an approaching engine. A barrier extending from the corner is used to compel a position from which the track is visible.

It is sometimes necessary to convey material by hand truck or wheelbarrow across a track. Amid the noises of a mill the approach of a train might be unheard. A suitable swinging barrier is used to permit passage and at the same time induce the worker to take notice and avoid danger. Such a device is illustrated in plate 4. This gate has springs which make it self-closing.

Frequently it is desirable to prevent cars from being thrown beyond a given point where it is undesirable to place a permanent barrier. The provision of a movable bumping block affords a satisfactory method. Such a block is shown in the illustration (pl. 5) at "A." In the same illustration is shown at "B" an exhaust pipe carried high enough to prevent steam from obstructing the view of the track.

In other cases in which it is wished to shift the obstruction from place to place as circumstances may demand, the "skidder" is used. Plate 6 shows a "skidder" with target attachment. This device gives the same warning as an ordinary target and also stops within

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PLATE 2.—GUARDS IN FROG AND GUARD RAIL.

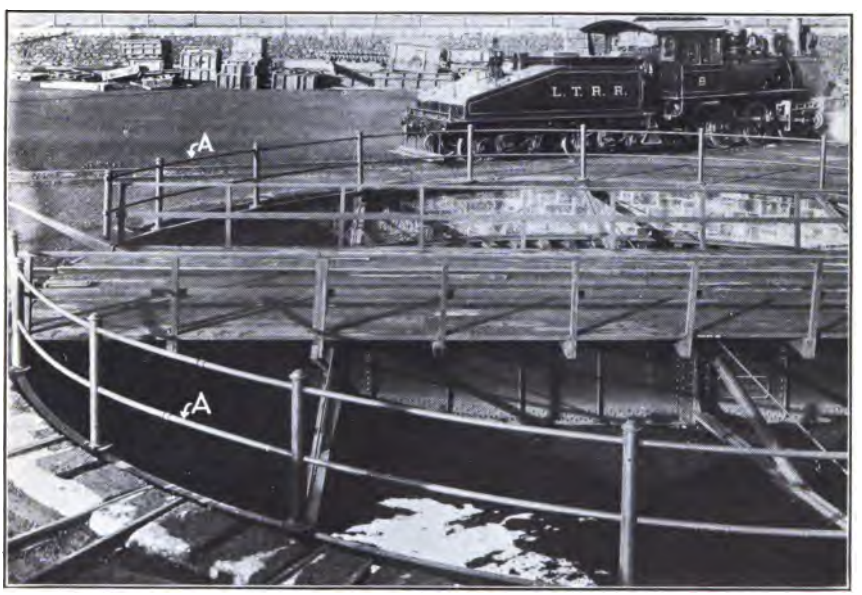

PLATE 3.—GUARD FOR TURNTABLE PIT.

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PLATE 4.—SELF-CLOSING SAFETY GATE.

PLATE 5.—MOVABLE BUMPING BLOCK.

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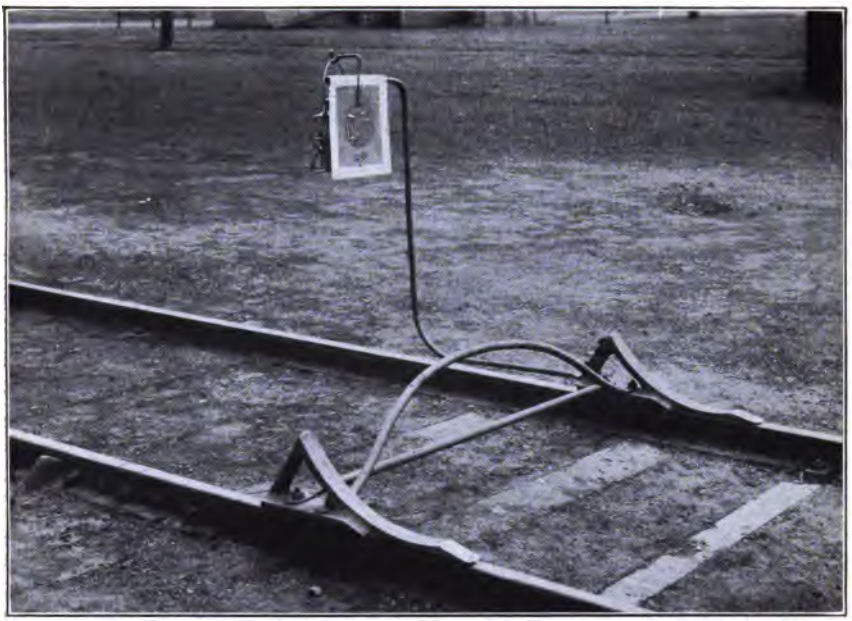

PLATE 6.—SKIDDER, WITH TARGET ATTACHMENT.

PLATE 7.—TARGET SIGNAL, USABLE DAY OR NIGHT.

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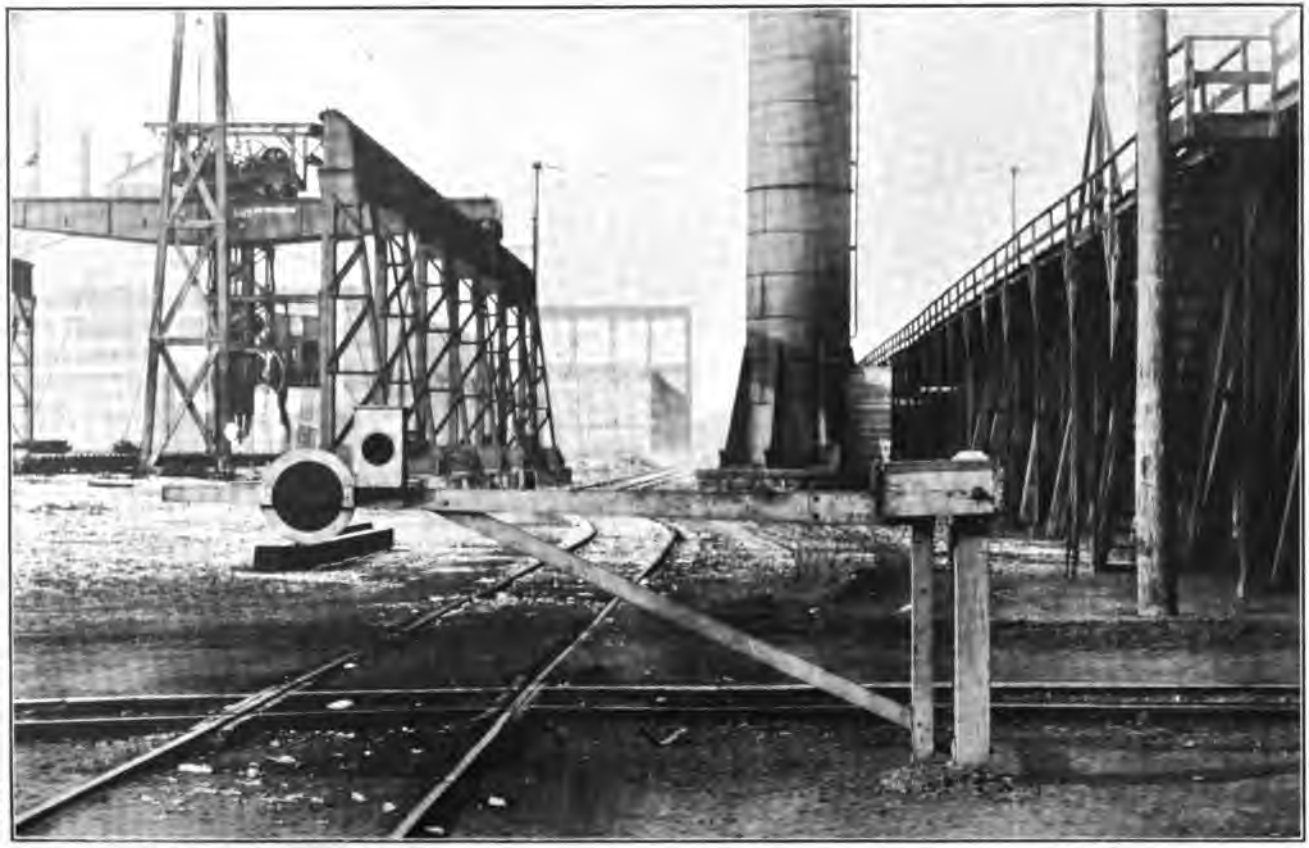

PLATE 8.—SAFETY GATE FOR CROSSING OF TRACKS.

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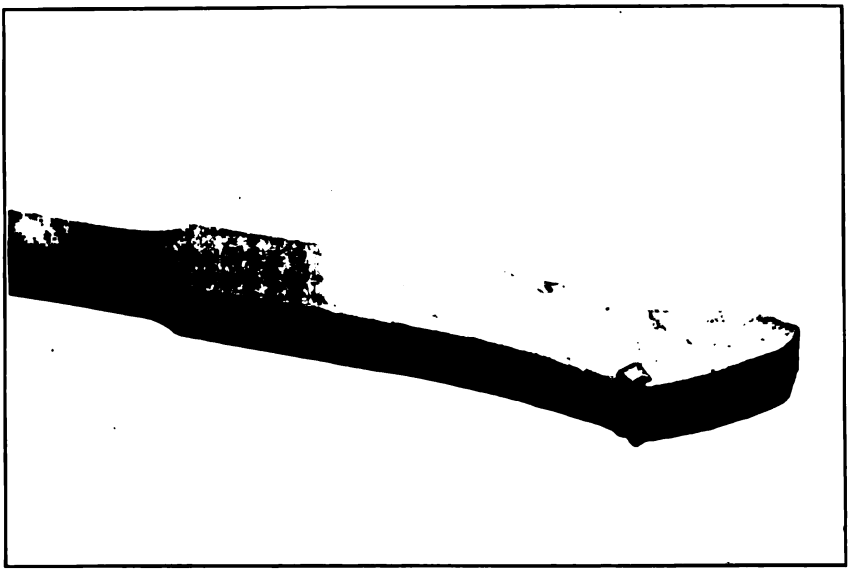

PLATE 9.—CAR SHIFTER, WITH "REX" STEEL HEEL.

PLATE 10.—CAR SHIFTER, WITH STEEL DISK TO PROTECT FINGERS.

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PLATE 11.—WRENCH FOR DROP BOTTOM CARS.

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PLATE 12.—YARD TRESTLE, WITH VARIOUS SAFETY DEVICES.

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4 feet a car moving at the rate of 6 miles an hour. For permanent track terminals a substantial bumping block is necessary.

When cars are standing upon loading tracks injuries have frequently arisen from other cars being shunted into them. A signal, shown at "A" (pl. 7), usable day or night and readily attachable to the rail, affords a safeguard. At "B" is shown a "no clearance" sign, and at "C" a safety handrail.

In mill yards it frequently happens that broad-gauge and narrow-gauge tracks cross. A signal (pl. 8) is used which can be easily shifted in such a way as to close the unused track. A red light is displayed at night.

In yard operations it is often necessary to shift a single car for a short distance when no locomotive is available. This is accomplished by "pinching"; that is, prying under a wheel with a crowbar. Often this bar slips and the user falling catches his hands between the bar and the rail. A special form of bar is used to prevent such slipping and to provide protection in case it should occur. In plate 9 is shown the large end of such a bar, with a four-cornered "Rex" steel heel inserted which bites the rail with practically no slip. When one corner of this steel becomes worn it is driven out and turned so that another corner can be used. In plate 10 is shown at "A" a steel disk, 5 inches in diameter, attached to the bar in such a manner as to prevent injury to the fingers in case the bar slips or turns and the man is thrown forward.

In many mill-yard operations dumping cars are used. When a rigid wrench is used in dumping these the weight of the contents may, when released, pull the wrench from the worker's hands and cause it to revolve and strike him a severe, perhaps a fatal, blow. A jointed wrench (pl. 11) is used which makes the operation very much safer. This wrench is constructed with a hinge joint. If it is pulled from a man's hands, it flies part way around, the joint opens, and the wrench falls off without striking the man.

It is frequently necessary to carry a track upon a trestle in order to reach the elevated floor of an open hearth or for some other purpose. Not long ago these trestles were constructed with neither rail nor footwalk, so that the men who now and again traversed them in the carrying out of their duties ran serious risk of falling through or being knocked off. Now they are generally completely planked in and are provided with a substantial railing, as is shown in plate 12 at "A." In addition to this safeguard the illustration shows other valuable devices about the trestle. At "B" is an expanded metal shield on the standpipe ladder to prevent employees from touching high tension electric wires; "C" is a telltale to warn trainmen of no top clearance at entrance to boiler house; "D" is a shield to prevent men from climbing high tension poles; "E" is a danger sign placed on all such

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poles; and "F" is a white box around guy wires to prevent men from being injured by coming in contact with them at night.

Often in the northern part of the country cars run and workmen are employed near buildings upon which snow and ice accumulate, and are very likely to fall whenever slight thawing occurs. A method of guarding against this danger is the use of snow shields, constructed of ¾-inch pipe in several strands, placed on the edge of the roof.

In yard work cranes of various descriptions play an important part. The ordinary overhead electric crane whose tracks are most frequently carried on the walls of a building may be brought out from a building on a suitable framework, or may have this supporting framework entirely independent of a building. These yard cranes very frequently carry electric magnets for the transport of pigs, billets, blooms, etc. This adaptation of the crane has done away with much of the most severe work of handling raw material and products.

Not long ago no adequate means was provided by which cranemen could reach the crane cabs. One company illustrates its own progress in this particular by pictures of a man climbing a column, another ascending a vertical ladder, and a third going up a stairway and comfortably carrying a basket of tools. The vertical iron ladder has been found to be satisfactory, especially when it stands far enough from the wall so that the cranemen can use the space between ladder and wall for his ascent. The cranemen's ladder and platform shown in plate 13 prevent a man from climbing high enough to accidentally take hold of the power rails and also from being brushed off the ladder by a crane cab. The best plants are rapidly introducing substantial iron stairways wherever they can be used.

Not very long ago in order to inspect or repair a crane the worker was obliged to get out as best he could upon the girder, and if he loosened any part of the machine in his repairs there was danger that it would fall upon those below; in fact, the breakage and fall of parts from the crane was a very common occurrence. Recent advertisements of cranes show that makers now very generally provide a walk along one or both sides of the crane, overhung gears are disappearing, and provision is carefully made to prevent parts from falling. An important contribution to this change has been the elaborate crane specifications of the Association of Iron and Steel Electrical Engineers. In the mills a revolution is going on by adding to the old cranes arrangements for the safety and comfort of the operators and others working upon them. Plate 14 shows the provision of railed bridge runways to prevent cranemen from falling; also of brushes in front of truck wheels to warn persons holding on to the rail of the approach of the crane.

The gantry crane is a bridge-like structure, the legs of the bridge taking the place of the walls or supporting framework. This con-

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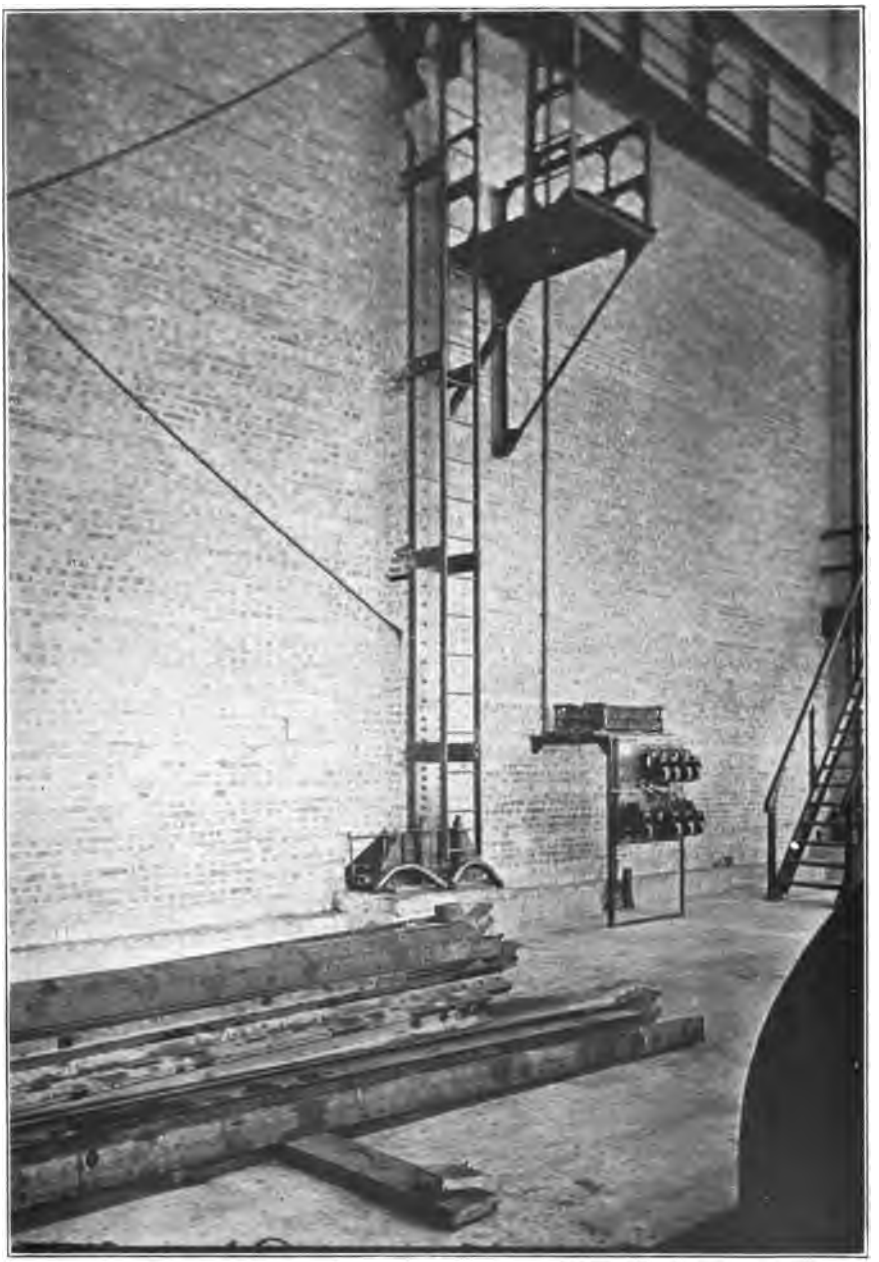

PLATE 13.—CRANEMAN'S LADDER AND PLATFORM.

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PLATE 14.—RAILED CRANE BRIDGE RUNWAYS.

PLATE 15.—GANTRY CRANE, WITH WHEEL FENDERS, GEAR GUARDS, AND RAIL CLAMPS.

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PLATE 16.—LOCOMOTIVE CRANE.

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struction brings the gears for propulsion near the ground and also exposes the laborers to the danger of being run over by the wheels upon the track. In the illustration (pl. 15) are shown fenders covering the wheels at "A," driving gears covered at "B," a shield for the knuckle joint at "C" so that inspection can be made readily, rail grips adjustable by hand at "D," rail clamps at "E" used in case of high winds, and concrete retaining wall at "F" to keep coal from tracks.

For the purpose of doing miscellaneous lifting and shifting in any part of the yard reached by tracks the locomotive crane is employed. The engine of this crane is so connected by gearing that it can at the will of the operator cause the crane to move along the track, raise and lower the boom, or swing the boom around. In swinging the boiler and engine also revolve. (Pl. 16.) All these cranes are subject to the danger of tipping when power is applied to the hoist ropes. Two safeguards have been adopted to remedy this difficulty: (1) Upon the boom where the operator can see it plainly is an indicator ("A") showing what loads are permissible in different positions of the boom, the iron plate at "B" showing the capacity of the crane with hook at various radii; (2) a U tube containing mercury is placed near the base of the boom and so adjusted that when tipping begins an electric contact is made and an alarm is rung. Since several deaths have occurred from the upsetting of these cranes these precautions are amply justified. At "C" is shown a structural extension to the frame which allows the use of an automatic coupler, operated by a lever at "D," by which the crane can be coupled to a car without danger. The triangular spaces at "E" are filled so as to prevent a man from being caught by revolving overhanging end of crane. "F" is an automatic fender.

This machine illustrates the fact that a given danger may exist for a long time without any one becoming aware of it. The picture shows that the boiler in swinging around passes very close to the bed of the car, the boiler and the edge of the car thus having the relation to each other of the blades of a pair of scissors. Clearly anyone caught in this angle would suffer severe, probably fatal, injury.

Cranes of this type had been in use for many years with no recorded accidents of this kind. Then, within a month, one company had three accidents, two severe and one fatal. The fatal case was that of the master mechanic of the plant who was investigating the accident to the workmen. He had just remarked upon the apparent impossibility of being caught when he himself was crushed fatally. These two accidents and the fact that at another plant similar injury had occurred led to immediate study. In these cases the crane was standing on the track lifting and moving material. Two devices

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were designed which would prevent anyone from getting into the dangerous place. When the crane was to be moved from place to place, the devices folded up snugly against the side of the car out of the way in passing objects alongside the track. With these devices installed and orders issued that in no case should the cranes be used without adjusting them, the safety men felt that the danger was cared for. Some months later a crane was ordered to shift from one part of the yard to another. The switchman passed on ahead to adjust a switch. As the operator followed he realized that in the new position the boom should be in the opposite direction. He proceeded to swing the boom. In this motion his position naturally became such that he could not see the switchman. Apparently the latter, as the crane came opposite him, did not notice that the boom was being swung and stepped on the corner of the car to ride, as he had done safely many times before. Immediately he was caught and killed. The device provided for prevention was useless, designed as it was for a different condition.

The outcome of this last accident was to have the boilers of all the cranes so changed as to give a clearance of 14 inches between boiler and car bed. Such an incident emphasizes the vigilance with which conditions must be watched if reasonable safety is ultimately to be gained.

Thus far the difficulties discussed in yard practice have been those common to all large industrial plants, although the conditions in the steel mills are, on account of the quantity and character of the material to be moved, more serious than elsewhere. In addition to these difficulties, the transport of molten and hot metal presents problems of its own.

In two particulars the molten-metal cars are being much improved. Formerly they were coupled by the link and pin method, exposing the switchman to the danger of that method with the occasional added hazard of a splash of hot metal. The couplings are now almost uniformly of the Janney type of automatic coupling used by the railroads. These are frequently supplemented by chains which come into play if the coupling breaks. The second particular is an improved trunnion arrangement. This largely removes danger of tipping when rounding curves (pl. 17). The handling of these ladles when going to the Bessemer and open hearth will be treated in that connection.

On cinder ladle cars the Janney coupling is used or a special type in which the pin comes up from below and is actuated by a lever, as shown in plate 18 at "B." The ladles are often provided with reenforcing bands, shown at "A." Since serious accidents have occurred from the oversetting of these cars they are in some cases

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PLATE 17.—HOT METAL LADLE AND CAR, SHOWING DOUBLE TRUNNIONS AND SAFETY CHAINS.

PLATE 18.—AUTOMATIC COUPLER ON CINDER LADLE CAR.

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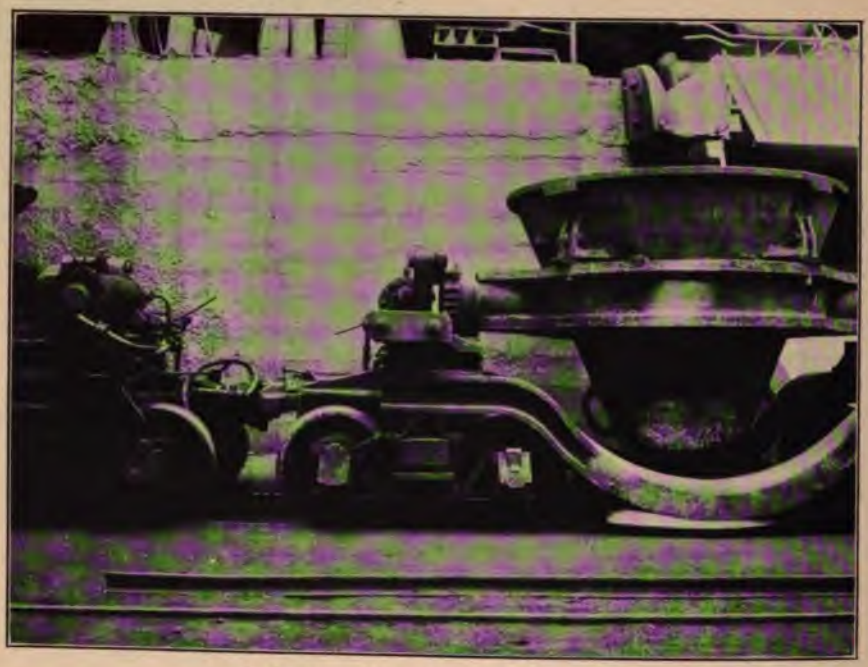

PLATE 19.—HEAVY BOTTOM CINDER LADLE.

PLATE 20.—AUTOMATIC COUPLER ON SLAB CAR.

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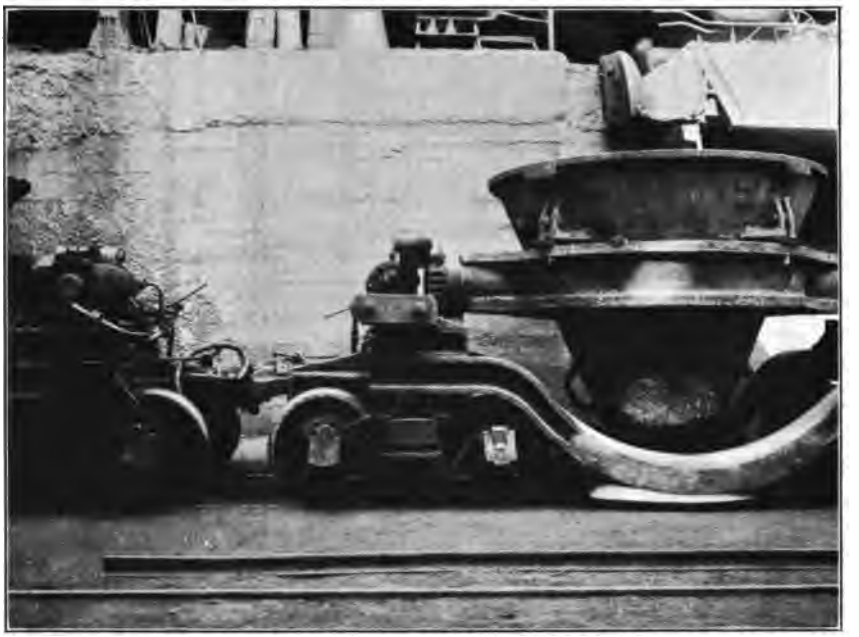

PLATE 19.—HEAVY BOTTOM CINDER LADLE.

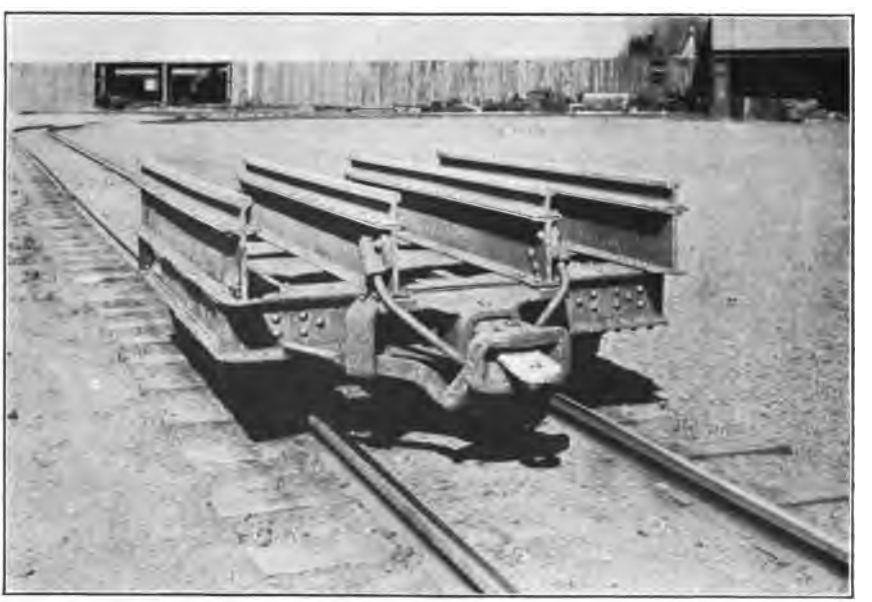

PLATE 20.—AUTOMATIC COUPLER ON SLAB CAR.

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PLATE 21.—AUTOMATIC COUPLER ON MOLD CAR.

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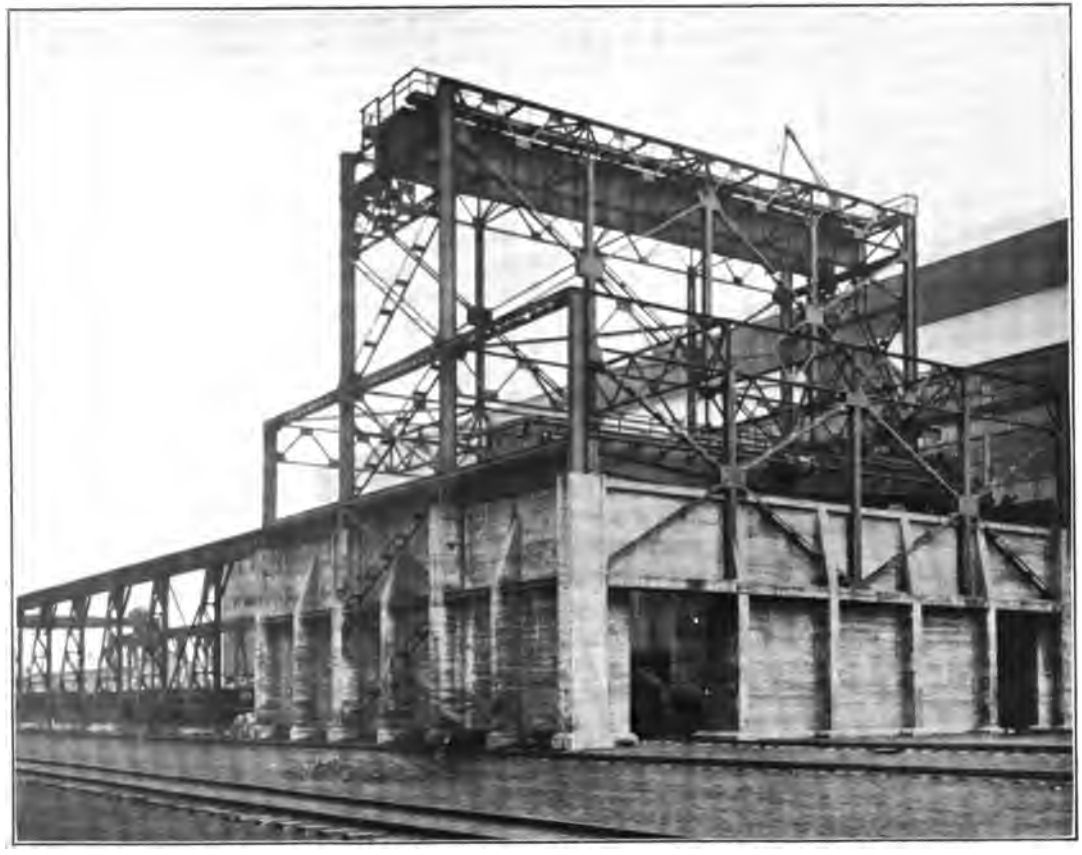

PLATE 22.—INCLOSED "SKULL CRACKER."

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provided with special blocking arrangements or are cast with a specially heavy bottom (pl. 19) which tends to keep the ladle upright.

The various small cars used in transporting slabs (pl. 20) or for the transport of ingots and molds, usually called mold cars, are regarded by many as impossible to couple except by the ordinary link and pin method. The chief point made against automatic coupling for mold cars has been that the molten steel is liable to fall upon them and upon cooling effectually prevent proper action, but in a number of plants the form of coupling in which the pin enters the coupling box from below has been in successful use. In plate 21 a mold car appears with a coupling of this kind at "C." The method of operating this particular coupling is such that the objection stated above might apply, but careful observation did not disclose any cases in which operation was seriously impaired. In this illustration is further shown at "A" the "dope" pit for oiling the narrow-gauge equipment and handrails at "B" to prevent men from walking into the pit at night.

An incidental yard danger arises in connection with what are called "drops" or "skull crackers." The "skulls" of cooled metal which form within the ladles have to be pried out at intervals. In order to remelt these and save the metal they must be broken in pieces. Some forms of scrap also have to be broken for use. This is accomplished by raising an iron ball, weighing up to 3 tons or more, and allowing it to fall upon the material which it is desired to break. It will readily be seen that fragments may be projected with much violence from this process. When it was conducted in the open the workmen in attendance and those at considerable distance were endangered. The first step was to erect barricades, but in some mills the space is now entirely inclosed, as shown in plate 22.

BOILER HOUSE AND ENGINE ROOMS.

The mills use enormous amounts of power. Since the manufacture of coke and the operation of blast furnaces is a feature of so many plants quantities of gas are available for heating and power generation. Until a comparatively recent period much of this gas was wasted, particularly in the process by which most of the coke was made. In fact, the great demand for coke causes the old wasteful methods to be continued. The presence of the gas as a source of power has been a factor of the large use in industry of the gas engine. This relatively direct application of the energy is a very great economy.

With this development, which has lessened or removed a number of dangers, a new one has been introduced. This is particularly true where the gas from blast furnaces is used. This gas consists very largely of carbon monoxide, which is a dangerous poison since it has

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no odor or other characteristic by which its presence may be detected. Fortunately other gases which have some warning odor are usually mixed with it. Still, rather frequent cases of fatal asphyxia have occurred both in connection with gas washers and gas-engine houses. Careful ventilation and strict requirement that workmen do not visit dangerous localities without having some one on guard are the only possible precautions.

In boilers fired with gas from blast furnaces the cleaning of boilers becomes particularly dangerous, since leakage from boilers still in action to those in process of cleaning may sometimes occur. The insidious character of the gas may be illustrated by the following: In a large horizontal overhead gas main flue dust accumulated from time to time and required removal. The plan had been to shut off the main from the furnace, open the manholes and other openings, and later, when the gas had disappeared, to send in a gang of men to shovel out the dust. On the occasion under consideration the usual precautions had been observed, the foreman had passed through the pipe to be sure that the condition was satisfactory, and the shoveling gang of six or eight had entered. No inconvenience was experienced until the shoveling began. Several men were soon overcome, and in the effort to remove them the remainder of the crew became unconscious. The alarm spreading, others under the direction of the assistant superintendent of the plant entered the pipe, and finally all were removed and revived, not, however, until the superintendent and 10 others besides the original crew had been overcome and more than 30 in all had been in the pipe. Apparently the gas was caught in the dust, escaping when it was disturbed and producing the result described. Hereafter the pipe will be cleaned by flushing with a stream of water. This is another illustration of the fact that a danger may be for a long time undiscovered and then unexpectedly become obvious.

In the ordinary coal-fired boiler mechanical stokers are now much used, affording economy of operation and relief for a very arduous occupation. In some of these stokers there are parts which move with such speed that a protective covering may properly be required.

It is necessary for the water tender to inspect the water gauges and attend to other items about the upper parts of the boiler. Platforms convenient and well constructed are now being provided for this purpose, as shown in plate 23. In connection with the platform attention is called to the toe boards, shown at "C," and to the wire netting, at "A," which prevents employees from being struck by the traveling coal-hoist crane, indicated at "B." The glasses of the water gauges are apt to break when steam is first turned into them. A screen of wire or tin may be used to protect the workers' eyes in

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PLATE 23.—WATER TENDER'S PLATFORM.

PLATE 24.—BOILER VALVE CLOSED AND LOCKED.

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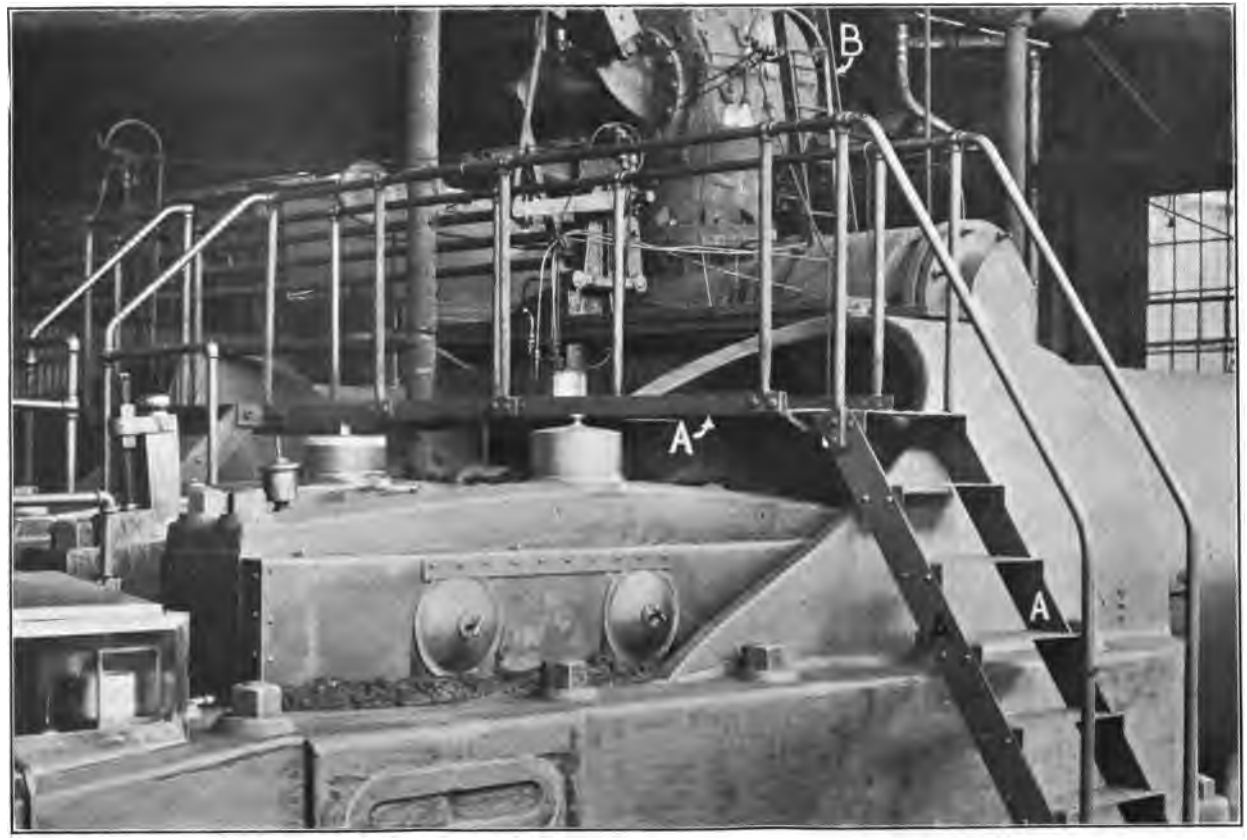

PLATE 25.—OILER'S PLATFORM AND STAIRWAY.

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PLATE 26.—SHIELD FOR FLYWHEEL.

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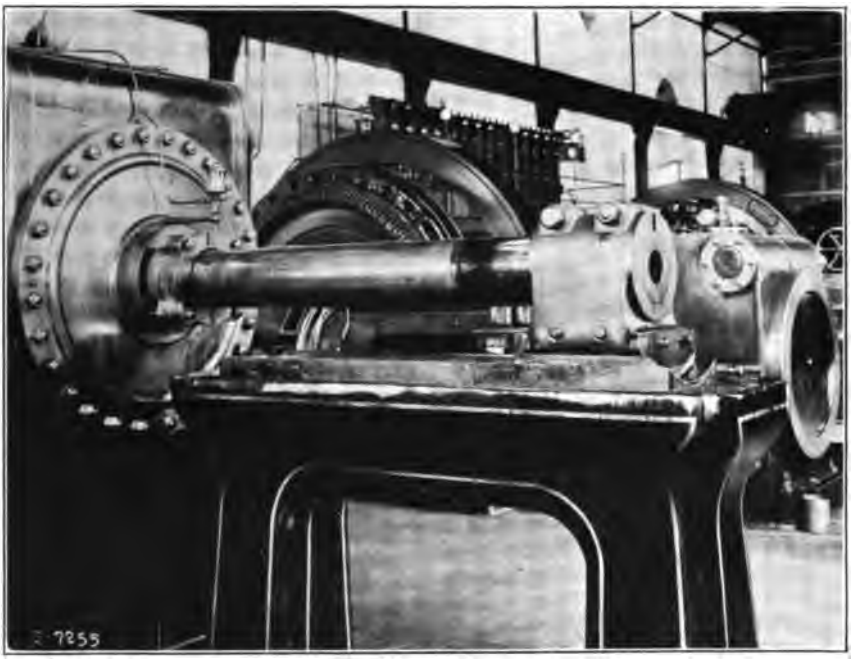

PLATE 27.—EXPOSED PISTON ROD.

PLATE 28.—SHIELD OVER PISTON ROD.

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such cases, or a wire may be inserted in the glass to act as a conductor of the sudden heat and prevent the glass from breaking and flying.

Where several boilers are operated in a battery, it has happened that a repairer or cleaner within the boiler has been scalded by the opening of a valve, permitting steam to enter from another boiler. To avoid this, both inlet and outlet valves may be securely locked by some such device as that shown in the illustration (pl. 24). Since this can be unlocked and the valve set free only by the man who is working in the boiler, his safety is placed in his own hands. The numbering of the boiler and each of its valves, as shown, is an important precaution, since workers have been known to lock the valve on one boiler and then enter another. This numbering tends to prevent such a mistake.

The most dangerous work about an engine is that of the oiler and wiper. Modern engines are so nearly automatic in their ordinary operations that an engineer runs little risk. He must be skillful and watchful to do the necessary thing in emergency, and his compensation is a measure of knowledge rather than of labor. His assistant, the oiler, must, however, approach rapidly moving parts and constantly take some risk in the ordinary round of his duty. The illustration (pl. 25) shows an engine which as received from the makers required considerable climbing in dangerous nearness to the moving parts. The provision of convenient and adequate means of approach by the platform and stairway, at "A," and the ladder, at "B," to reach the valves nearly removes the danger.

In this matter, as in the design of machines, a great change is occurring among the manufacturers. This is partly due to necessity arising from the size of the machines, which are, on this account, inaccessible without special means, but largely the improvement comes in response to an insistent demand for safety in operation.

A very common danger of the engine room comes from failure to fence flywheels. Plate 26 shows a fencing admirable, but not quite adequate. The fencing shown is about 4 feet high. The best practice now requires a height of 5 feet, or, if less, that the fencing be at least 18 inches from the wheel.

In the type of engines now much used the piston rod is carried through the end of the cylinder in order to insure steadiness of operation. This exposed rod, moving, as it often does, with considerable rapidity, is decidedly dangerous. The illustrations (pls. 27 and 28) show how this condition is remedied by the use of a shield.

In the direct driving of a dynamo from either a steam or gas engine the huge crank and shaft present an opportunity for serious injury. The complete inclosure of the moving parts is the effective safeguard used.

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In the repair of engines, especially of the huge blowing engines of the blast furnaces, it is sometimes necessary to enter the cylinders. A number of cases are on record where a flywheel slightly heavier on one side than on the other and not securely fastened has been jarred into motion by the work within the cylinder, causing the unfortunate worker to be crushed. A notice like the following has been used in a number of plants:

NOTICE.

All persons are positively forbidden to enter an air or steam cylinder of any engine until flywheel or crossheads have been securely blocked, to prevent possibility of engine turning over. See that a danger tag is placed on the throttle valve or any other valve the opening of which would admit steam to the cylinders.

It is always possible that from any of several causes, such as accident to the governor, an engine may be forced beyond its normal speed. This may cause serious injury to both men and machines. The engine may wreck itself and in doing so cause injury or loss of life. An effective preventive of such occurrence is a speed limit. In the type shown in plate 29 the spring band attached to and surrounding the shaft is so adjusted that at normal speed it clears the contact maker; but whenever speed rises above a certain limit, the band yields to the centrifugal force and closes the circuit. This at once operates an engine stop, which in turn acts upon a quick-closing valve, stopping the engine.

Very often the stoppage of the source of power would avert an accident or render it less serious. The most readily adapted plan is an electrically operated engine stop. Push buttons conveniently located or cords hanging near the machines may be used either to make or break a circuit and bring either motor or engine to a standstill. The engine stop, shown in plate 30, is an open-circuit arrangement, the electromagnet becoming active when the current is turned on. "A" shows the engine stop when the valve is open and "B" when the valve is closed.[1]

The closed-circuit method of accomplishing the same result has one very decided advantage. In this the constantly flowing electricity holds the throttle open. Upon breaking the flow, or even weakening it to any considerable degree, the throttle closes. It will be at once apparent that such a device is self-testing. While the current is in action the engine runs. With the open-circuit form there is a degree of risk that at the critical moment the current may not be active and the mechanism fail to work.

[1] Since this was written this speed limit and engine stop have been combined and much improved in design and operation.

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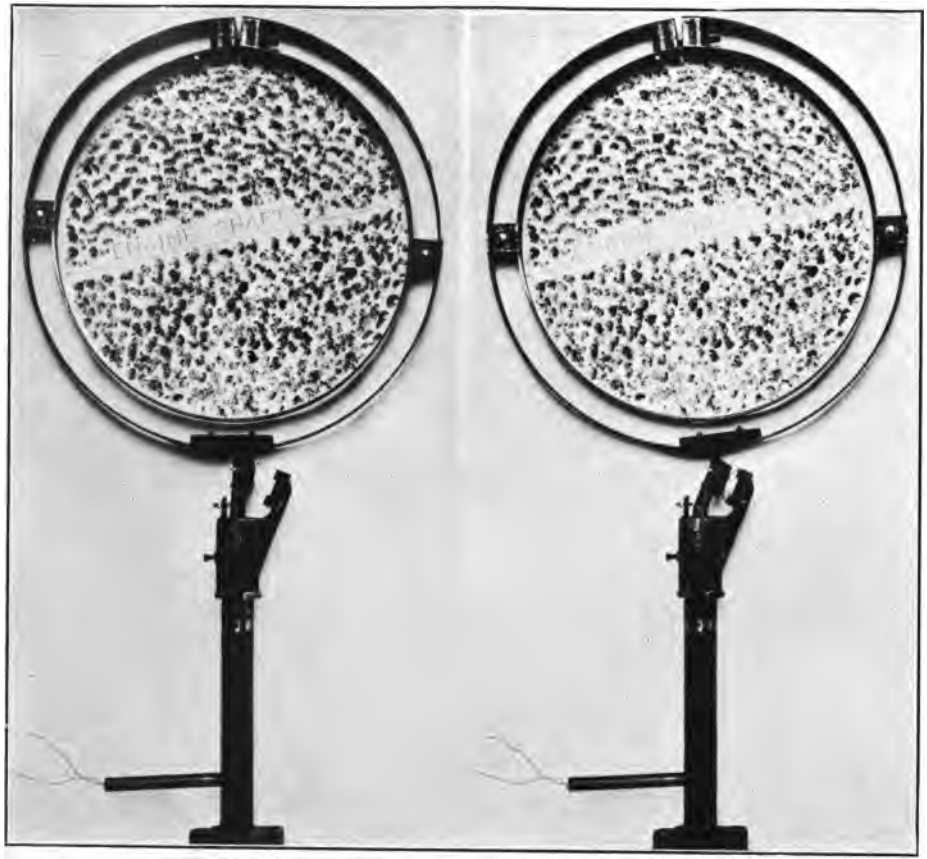

PLATE 29.—SPEED LIMIT ON ENGINE SHAFT.

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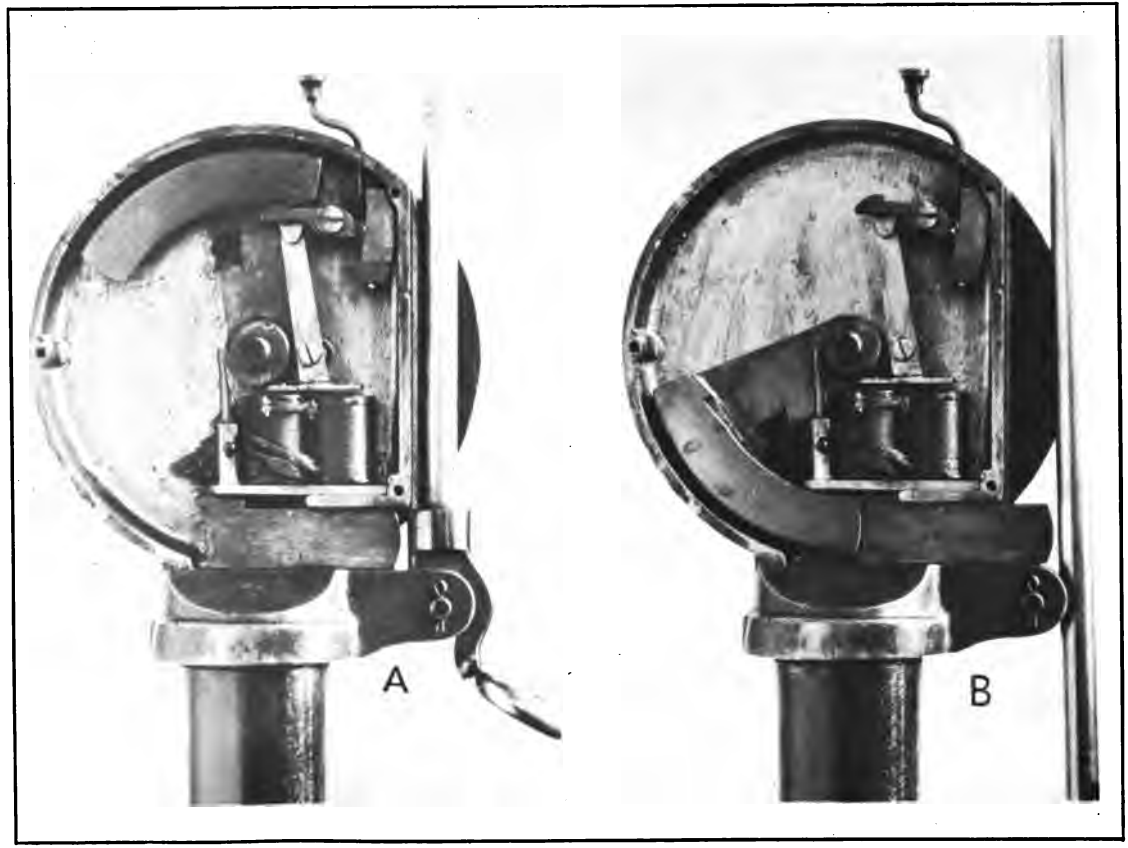

PLATE 30.—ENGINE STOP, WITH VALVE OPEN AND WITH VALVE CLOSED.

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PLATE 31.—SHORE END OF ORE UNLOADER, WITH SAFETY DEVICES.

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PLATE 32.—FENDER ON TRUCK WHEEL OF ORE UNLOADER.

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ORE DOCKS, BRIDGES, AND CONVEYORS.

The scope of this report has not extended to mines and transportation of ore. It begins with the arrival of the ore at the dock or railway siding. From ore boat to shore the shift is made by means of ore unloaders of different patterns. The dangers of these machines are mostly related to four situations: The operator who handles the electric controllers suffers an occasional burn from a flash or short circuit; the oiler, who climbs about the beams, may become entangled; the repair man or rigger has a risk; and the shoveler in the vessel's hold may be struck by the descending grab, which takes up tons of ore at a time, or falling lumps may bruise and batter him.

Since the electrical dangers are the same everywhere, they will be discussed further on in a general consideration of the applications of the electric current.

The illustration (pl. 31) shows the sloping hoistway by which the ore is carried up the harbor bank and dropped over into the bin or trough behind the concrete wall. A plate guard ("A") under the way prevents the slack cable from striking persons passing beneath and also the falling of material to the passage below, a railed walk ("B") affords safe access of the oiler to the machinery, and a stout barricade ("C") secures a passing worker from falling down the bank.

The unloaders move upon tracks parallel to the harbor bank and present the same dangers that have been already described in discussing gantry cranes. The illustration (pl. 32) shows at "A" the cast-iron fender provided on front truck wheels.

The ore bridge resembles both in form and operation a gigantic gantry crane. The trough of solid masonry, or more frequently of concrete, which parallels the harbor bank or the railway, has already been considered. When the ore arrives by rail, it is very often put into the receiving trough by car dumpers, which pick up a car of coal or ore as a cup might be lifted and pour its contents into the bin. More often, perhaps, the cars are provided with bottoms which open to discharge the contents. The material thus accumulated in a long and narrow mound in the receiving trough is removed by a grab bucket. This is lowered into the trough, grasps some tons of ore, and is then lifted and carried at right angles to the trough. The load may be dropped either upon the stock pile or carried completely over it and placed in transfer cars upon the stock trestles. The dangers of this apparatus, somewhat augmented by its greater size, are similar to those pointed out for unloaders. The safeguards are the same.

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BLAST FURNACES.

RELATION OF SAFETY PROBLEMS TO OPERATION.

It became evident very early in this study that in the blast furnaces a problem was presented quite different from that of any other branch of the industry. Safe operation involved some fundamental considerations of method not yet fully settled by furnace men.

It was also clearly noticeable that the solution of operative problems with reference to production would also solve the safety problem. The difficulties which render production uncertain also underlie the dangers. In other departments of the industry much can be done by protective devices; in the blast furnaces comparatively little.

It is manifestly impossible in a report like this, intended to be descriptive and suggestive rather than technical, to give an adequate discussion of this sort of a problem. The attempt to present its salient features is justified, however, by the fact that the investigation has assembled much not on record elsewhere, and by the further fact that the viewpoint is new. The effort to increase production has been even more conspicuous with furnace men than with others. The admitted dangers of the occupation, and the apparent impossiblity of lessening them materially, have also delayed study from the safety standpoint.

In the study of industrial accidents the discovery has often been made that a problem of production had been given long and careful attention with no satisfying result, but finally in the effort to provide safeguards the desired productive result has been incidentally attained. The point on which success turns may become apparent only when the question is approached from a new direction. This will be true in a vast number of industrial conditions. Aside from the direct value in prevention of injury and safeguarding human life, the safety problem deserves earnest study, for out of its solution may grow some far-reaching and important operative gains.

The blast-furnace man's difficulties begin with his raw material. As the discussion proceeds it will become evident why variations in the quality of these is a matter to which he must give earnest heed.

THE MODERN FURNACE.

A modern furnace may be regarded as made up of three primary elements: (1) The blowing engines, (2) the stoves, and (3) the furnace proper. Historically the last of these is first, the others having been added in the course of development. The early stacks were very simple towers of masonry into which ore, limestone, and charcoal were dumped.

The illustration (pl. 33) affords a view of two of these primary elements, the stoves on the left and the stack or furnace proper in

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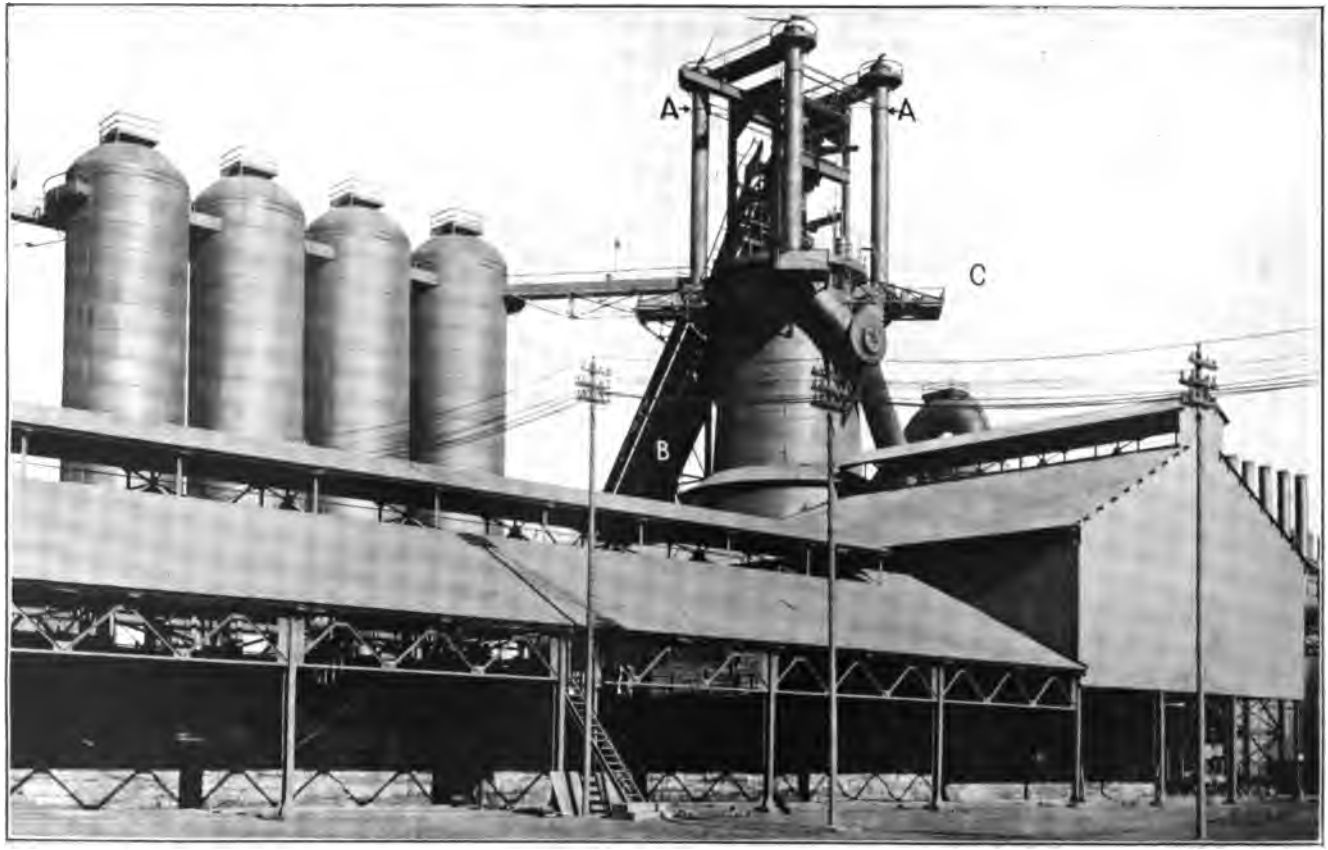

PLATE 33.—BLAST FURNACE AND STOVES.

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the center. Into the stacks are emptied by various means, discussed elsewhere, the carefully proportioned quantities of fuel (usually coke), the chemical flux (commonly limestone), and the ore.

A section of a furnace discloses three portions, a cylindrical hearth at the bottom, above this an inverted truncated cone called the bosh, and above this an upright truncated cone, the stack. The outer wall of these portions is heavy metal, within which is a lining of refractory material varying from 9 inches to 6 feet in thickness.

The shape of the stack permits the free downward passage of the materials. As they reach the bosh fusion takes place, the bulk decreases, and the diameter is decreased accordingly. The cylindrical hearth at the bottom serves as a reservoir for the molten metal in the intervals between its removal or tapping.

Around the furnace, near the point where the truncated cones join, is a large pipe, the bustle pipe. Into this is delivered air, forced by the blowing engine through one of the stoves. From the bustle pipes extend down other smaller pipes which at the height of an ordinary man turn inward through the wall of the bosh. To these pipes, in whole or in part, the name tuyeres is applied.

As thus described the furnace will appear to be a rather simple piece of apparatus, as indeed it is. The complication arises in the materials put in and in the behavior of the huge retort in operation.

The thing undertaken on this immense scale is a very delicate and exact chemical reaction, to which physical conditions of heat must be applied with the utmost precision. No one having the least knowledge of the difficulties encountered in the exact control of laboratory processes on a small scale and with easily manipulated instruments of precision will wonder that this combined physical and chemical problem on an enormous scale gives a great deal of trouble.

In connection with plate 33 attention is called to the steel plates covering the bottom of the skipway at "B" to prevent material from falling on workmen below, and to the provision of platform, toe boards, and railings to protect employees at furnace top "C." At "A" is shown the position of the explosion valves designed to guard against danger from flame when the furnace "slips" (see p. 203) and to prevent material from being thrown out of the furnace upon the employees. These valves are so arranged that the material will drop back into the furnace.

BLOWING IN.

To operate a furnace, it is first "blown in," as furnace men say. A quantity of fuel in the hearth is ignited and allowed to burn by natural draft through the openings near the bottom. When the scaffold which has been used to uphold a portion of the fuel is consumed and falls, the introduction of material at the top begins. At

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a time varying according to the practice of the particular superintendent the tuyeres are put in place and a blast of heated air turned in. As the consumption of the original fuel occurs the coke introduced at the top comes down to the level of the tuyeres. The burning of the coke gives rise to a quantity of carbon-monoxide gas, while the heating of the lime expels carbon dioxide, leaving lime. The carbon dioxide thus formed unites with a further quantity of carbon, becoming monoxide. These gases with free carbon react upon the iron ore, which is an oxide, robbing it of its oxygen and reducing it to a metallic state. As this metallic iron descends to the level of the tuyeres it enters the "zone of fusion" and melts. As the melting proceeds a new chemical reaction occurs between the iron and the also fused flux. The slag resulting from the fusion of the flux and its chemical union with other substances, being lighter than the iron, floats on top of the molten mass, gradually accumulating in the hearth. It is drawn off through an opening, the cinder notch, at intervals more frequent than the tapping of the liquid iron. While these physical and chemical changes are going on, material is steadily charged from the top, keeping the level of the stock in the furnace constant.

Thus summarily are indicated the steps of a process which, once started, should continue with no interruption for months or, it may be, years.

This process had become quite standardized in apparatus and method and was proceeding in a manner which would now be considered absurdly slow when two factors intruded, destined to work a revolution in nearly every particular. These factors were the introduction of the Mesaba ores from Minnesota and the development of a tremendous demand for iron and steel products.

HANDLING THE RAW MATERIALS.

The above description makes evident that the gases generated in the process must pass through the overlying mass and so escape. With all ores hitherto used the ore consisted of granules or masses of some size. These when mixed carefully with the flux and fuel constituted a porous mass through which the gases would pass freely under rather moderate pressures. The ores of Europe are nearly all of this character, as are those of the Birmingham region and the imported ores of Cuba used in many eastern furnaces. The Mesaba ore is earthy and powders up so readily that it opposes a serious barrier to the passage of the blast. In the early experiments with this ore the natural recourse was to higher blast pressures. This succeeded in so far that the blast got through, but trouble went with it. Instead of passing through uniformly the blast was likely to force some special channel, perhaps seriously injuring the lining in that

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vicinity or setting up other undesirable activities, while the burden outside its particular path moved downward unchanged.

It will become clearer what the effect upon the furnace action of such disturbances may be if a series of events is followed. Suppose the impervious condition of the burden diverts the blast to one side. The part no longer supplied with the heated gases begins to fall in temperature. The lower portion, pasty and on the verge of fusion, congeals, and in so doing adheres to the furnace wall. This is the beginning of what furnace men call a "hang." Once started it may extend nearly or entirely from wall to wall, becoming what is called a scaffold. Of course the free descent of the burden is checked and the equilibrium of all the processes upset. It is evident that with the progress of combustion below such a hang or scaffold the support would soon be removed. To restore the action of his furnace, the furnace man resorts to various expedients to cause the detachment of the hanging portion. It may happen in mild cases in the ordinary course of events. When it does there occurs what is known as a "slip." When the support gives way the stock rushes suddenly downward, and this mechanical action may cause the ejection of material from the top of the furnace. The downward movement of the stock, the sudden release of the blast, and other purely physical activities may cause serious disturbance. This is not all, however. Explosive compounds are apt to be formed, as will be explained later. The action of these explosives may be slight, a "puff," as it is called, driving out dust only, or it may be violent, doing damage to the furnace top.

It would rarely happen that passage of the blast would be entirely cut off, though blast pressure might run dangerously high. If, in spite of efforts to dislodge it by taking off and putting on the blast and other devices known to furnace men, the hang persists, it may happen that all the carbon in the lower part of the furnace is consumed. If this happens and suddenly there is a break, the unconsumed oxygen of the blast coming suddenly into mixture with the furnace gases and into contact with incandescent coke above the scaffold may give rise to an explosion which will empty the entire furnace. It will be observed that the condition mentioned is not materially different from those of the dust explosions which occur in mines and which have occurred in flour mills. Indeed, for sudden and violent activity this situation is particularly favorable. Several such cases have been related by superintendents in which the contents down to the tuyeres were ejected and, of course, the top works of the furnace were completely wrecked. In one of these instances the ejected material covered the track of the adjacent railroad to a depth of 3 feet, delaying traffic for some hours.

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The American furnace man who is dependent upon Mesaba ore has a problem of which his European compeer has no idea. This is important in the present discussion, since if accident rates are compared without due attention to such differences injustice may be done. So far as the raw ore is concerned, the furnace man can not refrain from the use of these earthy supplies. The Mesaba ore constitutes the most extensive and one of the richest deposits now known. It is accessible and easily mined. To discard it for more easily worked ore is plainly out of the question. In spite of difficulty and danger it must be used. There is no possible preliminary treatment of this ore which can be applied on a sufficiently large scale to modify its troublesome character. The relatively impervious "burden" must be accepted and methods devised for operating with it.

With ore of a condition permitting free passage of the gases it does not much matter about the condition of the coke and limestone used; the use of charcoal and anthracite as fuel is not considered, since these are so inconsiderable and are not used in the reduction of the earthy ores. For a supply of coke the furnaces are dependent upon two processes. In the "beehive" oven the combustion of a portion of the coal and of some of the volatile constituents cokes the remainder. This process is enormously wasteful and can produce good results only with coal of certain original qualities, such that the product is of proper hardness and contains suitable proportions of volatile residue. The demands are so great that for a given furnace to secure its supply always from one locality, and so of uniform quality, is nearly impossible. This necessity for using a varying coke, some kinds burning more readily than others, and of unequal density, so that some easily breaks into powder while some is so hard as to resist the desired changes, gives the furnace man constant anxiety. Coke is now often purchased on the basis of chemical analysis, making possible definite specifications, but this does not guarantee physical condition, often of much importance.

The coke-producing method now having a very great extension is the "by-product" method. This is conducted in ovens so constructed that they can be charged with crushed coal derived from various sources and so combined as to give an exact result. It is possible with these ovens to turn out a uniform product if sufficiently exacting care is used. By building these ovens in the vicinity of the furnace plants and operating them with reference to special needs much trouble may be avoided. How the coke combines with the earthy ore to give rise to difficulty may be best indicated by some illustrations.

At one plant the screening apparatus by which the fine dust called "breeze" is removed from the coke was temporarily disabled. In the interval, to keep the furnaces running, coke was taken from the

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cooling tables of the ovens without screening. In a few hours the furnaces were hanging and slipping seriously. What happened was this. The coke contained much breeze. This mixing with the fine ore produced a still more compact mass, made more difficult the path of the blast, and started a cumulative series of changes producing trouble.

A second illustration brings out even more clearly the sensitiveness of the huge chemical and physical apparatus. A group of furnaces had for some days been behaving badly, ejecting 6 to 10 carloads of flue dust each daily, when normally the amount would not exceed two carloads. For some time the superintendent was at a loss to account for this behavior. Finally he discovered that the coal used in the ovens was being crushed to unequal degrees of fineness and the granules did not distribute themselves equally, the large particles of one quality accumulating in one place, while the fine material fell in another. The result was that some of the coke was not sufficiently resisting, was easily reduced to powder, and caused irregularity, as in the preceding case. In this also the more ready inflammability of a portion of the coke due to the imperfect mixture tended to shift the zone of fusion and institute its own series of difficulties. When the crushing was so changed that the pieces were uniform, the furnaces gradually resumed normal operation.

Of equal, perhaps greater, importance than the condition of the coke is the physical condition of the limestone. If the fragments are too small the earthy ore and the coke breeze tend to pack in between them and obstruct the blast. On the other hand, if they are too large it may happen that the limestone descends to the lower levels of the furnace without being changed to lime. This change postponed to this point makes a demand upon heat at a critical point where it is needed for other purposes. Since the setting free of carbon dioxide is a process not only useless but positively disturbing, both by robbing other processes of needed heat and by the changes which it sets up, this descent of large unchanged lumps of limestone is highly undesirable. More serious still is the result when there is much fine limestone dust in the charge. This not only combines with the earthy ore in obstructing the passage of the gases, but gives rise to lime scaffolds extremely difficult to dislodge and producing serious results when the slip comes.

The situation regarding raw materials may be summed up thus: The majority of American furnaces must accept a large proportion of troublesome earthy ore with little chance of modifying its undesirable qualities by admixture or by physical preparation. A uniform quality of coke properly screened and free from breeze should be increasingly available until such time as the coal supply seriously lessens. The physical preparation of the limestone by crushing and

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screening is possible and amply justifies the cost both productively and as a safety precaution.

The care suggested above in the preparation of coke and limestone is not regarded as necessary by all furnace men; indeed, might be rather vigorously rejected by some as wasted effort. The ideas expressed have two strong points in their favor. They are thoroughly defensible on theoretical grounds, and they represent practice which has been highly successful.

Given raw materials as carefully selected and prepared as possible it is important for them to be handled so as to secure safety and output. Since work must be done from time to time on and about the apparatus at considerable heights from the ground, safe stairs, railed walks, and other means of approach to the working stations are well known devices in use. Unfortunately, however, there are a good many, especially of the smaller furnaces, where difficult climbing in the vicinity of dangerously moving parts is still necessary. In all recent construction ample provision has been made in this regard.

For the moving of ore from stock pile to bin some form of dumping car is commonly used. This runs upon a trestle above the bins, which are 20 feet or more in depth. Plate 34 shows one equipped with headlight, warning whistle, and air brake. Before thus equipping the transfer car the company now using them had several serious accidents to the trestle cleaners. In front of this car at "A" is a passageway giving the operator access from the trestle walk to the car. At "B" is shown a method of guarding the openings into the pockets. Round bars are placed across the openings. Grids or screens of various forms have been tried for this purpose. All of these including the one shown, have objections, since, in winter, the ore frequently freezes into large lumps which will not readily pass downward into the bin. Experience seems to indicate that the main reliance must be on employing careful men at this work.

When transfer trestles pass near the furnaces a dangerous opening may be left at the point where the skip passes upward. The adequate safeguarding of such an opening is shown in plate 35, at "A." In this illustration may be noted also the trestle walks at "B" with handrail and toe boards; the bridge over skip way, at "C," which obviates the necessity of walking on or too near the tracks at such points; and the planking of the trestle at "D" to protect the roadway beneath.

A radical difference in construction and method appears according as the stocking of furnaces is accomplished by the hand method or by the mechanical method. In the first of these a gang of men commonly called bottom fillers take the raw materials in barrows or buggies from the stock bins to the hoist beside the furnace stack. The buggies, after being weighed, are wheeled upon the hoist and

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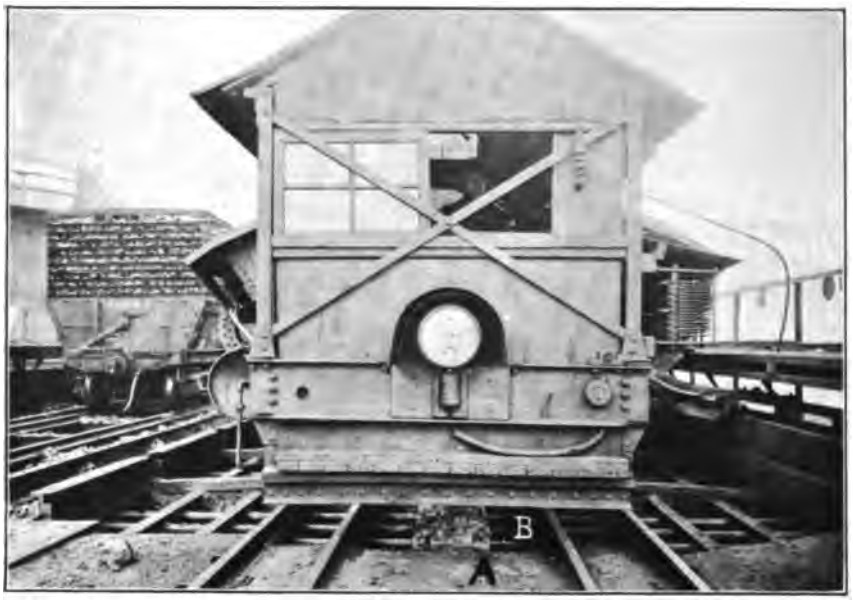

PLATE 34.—STOCK TRANSFER CAR.

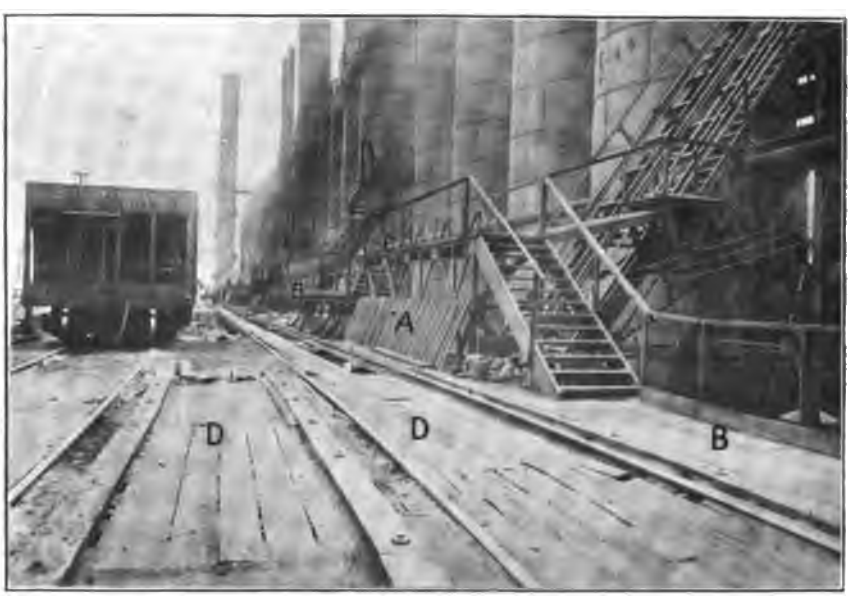

PLATE 35.—TRESTLE WALKS AND GUARDS OVER SKIP HOISTS.

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upon signal of the man in charge, the "cager," are lifted to the top of the hoistway. Structures vary, but as this type of furnace is old it is often the case that the platform at which the buggies arrive and the runway by which the top of the furnaces is reached are entirely uncovered and the workers there are exposed to the elements.

The size of the top filling gang varies, six being as few as can handle an ordinary furnace, while under extraordinary circumstances as many as 30 have been on the furnace top. The top fillers, under the direction of a foreman, wheel the barrows across the runway from hoist to furnace top. There they dump the contents into the hopper around the circumference of the bell by which the top is closed. There are in operation probably a few furnaces of a still older type, in which the top is entirely open and from which a constant flame arises. These are run with very low pressure, and while the operation of filling has a picturesquely dangerous appearance, it is probably less hazardous than in the furnaces under consideration.

The bell mentioned above is of iron, of the shape suggested by its name. It is so counterweighted that it closes the top of the furnace. When a complete circle of stock has been placed upon it, the bell is lowered and the stock slips from its edge into the furnace. When this is done the escaping gases often take fire, and for an instant a flaring torch waves from the furnace top. With the most accurate possible fitting of the bell constant leakage of gas occurs—the deadly carbon monoxide. The extreme case mentioned above, when 30 men were on the furnace, serves to illustrate the possibilities. The bell had become overheated and was leaking. The wind was in such direction as to blow the escaping gas toward the hoist. Because of this and the fact that the men could stand but the briefest exposure, the force had been increased from 6 to 30. Men were from time to time being overcome and dragged away unconscious. These were sent down in the hoist and new men came up. Finally, one man was suddenly overcome as he wheeled his barrow to the bell. He fell into the hopper against the bell and was severely burned before he could be rescued. From the combined effect of the burns and the poisonous gas he died. In his rescue the foreman and several of his fellow workers became unconscious. The effort to keep the furnace running was abandoned. An even more striking instance of danger is that of a furnace where a sudden outburst of flame so badly burned the 12 workers on the furnace top that all were either instantly killed or died later.

It must be kept in mind in this discussion that these cases of sudden death are exceptional. They are presented to show clearly the dangers to which, at rare intervals, this occupation is subject. They do not in themselves prove the highly hazardous character of the business since they might be so infrequent and other conditions so

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little hazardous as to render the worker in a blast furnace less in danger than in other forms of activity. The blast furnace has not only these exceptional dangers but such a proportion of ordinary hazard as to make its accident rate among the highest in the industry.

The passing of the top fillers' occupation with the introduction of mechanical methods must be regarded as most important from a safety standpoint. With the advent of Mesaba ore, greater size, and higher pressures there was a period in which the hazard of this occupation became most serious.

In view of the extreme hazards of the top filler on a furnace filled in that manner it becomes important to inquire into the reasons for continuing this form of work and what precautions are possible to render it less hazardous. The use of top filling is insisted upon by makers of foundry iron particularly, on the ground that they can secure better distribution of the stock in the furnace, and particularly that it is possible when trouble occurs to remedy the difficulty by changes in the distribution of the charge. This flexibility in charging enables them to produce a more uniform quality of iron and to avoid, by timely action, troubles which would become serious in a mechanically charged furnace. This claim is undoubtedly valid in some degree. The demand for uniformity of product from the blast furnace is more insistent when it is to be used in foundries than when it is to be used in producing steel. It is possible in the latter case to correct some of the irregularities of the furnace in the later processes. The contention regarding uniformity of product is becoming of less force as mechanical methods become perfected. A proper care in the selection and preparation of the raw materials, the use of the best methods for securing even distribution of stock, and the applications of other methods now available render it possible to accomplish by mechanical means all that can be secured by the hand method. Indeed, the claim has been made that the best mechanical methods are even more reliable than that which involves the variations due to human irregularity.

Some reduction of the dangers has been brought about by various modifications in structure. For example, the hoist is placed at a greater distance from the top; the top of the hoist is housed in, affording protection from the weather; improved bells greatly lessen the gas leakage; the ejection of hot stock may be entirely prevented.

In the mechanical or skip-filled type of furnace the stock is placed in a carrier or skip, which is then hoisted to the top and automatically dumped into the hopper. The stock is brought to the skip at the bottom of the inclined skipway and placed in position, either by barrows, as before described, or by various mechanical devices. The most common of these is a larry car, called, when it carries a

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weighing apparatus, a scale car. All these as now used are electrically driven and dumped at the furnace directly into the skip.

The difficulties of distribution which have served to keep the hand-filled furnaces in use for certain furnaces are the result of happenings all along the way. When the bottom fillers place the stock in barrows with shovels and forks they will, even if not instructed to do so, tend to mix the material into a more even mass. This mixture is rendered more perfect by special requirements of method and handling. The barrows are then carried to the point of emptying undisturbed. By care in this process the stock may be gotten upon the bell in a practically uniform mass. If the preliminary steps have been properly taken, the only chance for the sorting of the material is the final step from bell into furnace.

This sorting action, which has given rise to much trouble, should be briefly explained. Whenever a mass of material composed of fine and coarse particles slides down and drops from the edge of an incline the fine material tends to drop more directly from the edge, while the coarser particles are thrown forward to a greater distance. The result is a certain degree of sorting. With each repetition of the process the sorting becomes more pronounced. It has been noted that in hand filling this sorting occurs only once and that it is quite possible to vary the dumping upon the bell in such a way as completely to neutralize the difficulty. In mechanical filling the process is repeated at several stages: First, when the stock is drawn from bin into car; second, in dumping car into skip; third, when skip dumps into hopper; fourth, when material slides from small bell to large bell; and, fifth and finally, when stock drops into furnace. In skip-filled furnaces two bells, one above the other, are used in order to prevent escape of gas. This is desirable both because the gas is useful elsewhere and because its escape and combustion would endanger the mechanism. Each of the five sortings above mentioned may increase the difficulty, although at times they may occur in such manner as more or less to neutralize each other. The matter has been given thus in detail in order to show the difference between the methods and the recurring situations sure to produce an undesirable condition unless corrected.

It will be readily understood that with any material lacking in uniformity this sorting process going on unchecked will produce in one part of the furnace an open portion of stock through which the gases will easily pass, giving it an undesirably high temperature and permitting the furnace lining to be eroded or channeled on that side, while the relatively compact mass on the other side will remain cold and will descend toward the hearth in this condition, upsetting all the proper reactions. It can not be too strongly emphasized that

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this is a most delicately poised chemical and physical situation, in which a relatively slight disturbance may combine with other changes to produce ultimate results of a highly disastrous character both upon production and upon safety. The ideal of the furnace man is perfect uniformity and regularity of operation. When these are attained he will produce with both economy and safety. The ideal of his raw material would be spheres of uniform density. As it is impossible to secure material of this kind, he must approximate it as closely as possible and correct so far as he can the behavior of the material in its necessarily imperfect condition.

The methods of correction have been many and can not be detailed here. A few illustrative cases are cited. In the first the skip is a cylindrical bucket with a bell bottom essentially like the furnace bells. This bucket is carried on the car to the bin. As the stock drops in the bucket it is revolved at a suitable rate, which neutralizes the tendency to sorting. The bucket is then carried to the foot of the skipway, hoisted, and dumped into the hopper through the bell bottom. The shape of the bucket and its position at this time minimize the sorting effect of this transfer. This method takes out practically three of the five sortings and much modifies the fourth.

Another method is by revolution of the top, by which the stock is dumped in successive portions of the circumference and so produces uniformity. A third method was the result of much experiment. A full-sized skip car, hopper, and bells were constructed. The area into which the stock fell was divided into quadrants. The load was then dumped many times with the car in various positions, changes also being made in the shape of the hopper and of the bells. After each dump the material in each quadrant was sifted and the amounts of fine and coarse material determined by weighing. By prolonged experiment the best point for dumping and the best shape for the hopper and other parts were finally ascertained. The fourth device noted was an arrangement within the furnace which could be so adjusted that the material falling from the bell could be deflected differently from time to time and proper distribution secured.

The aim of this discussion is to emphasize the importance of the object sought to be obtained and the painstaking ingenuity expended upon it. These mechanical methods have now reached a point where it seems possible with them to attain the results possible with hand filling, together with important economies in operation and great increase in safety.

With the problem of mechanical stocking some incidental safety precautions are associated. The importance of providing safe and adequate means of approach to the working parts has been mentioned. The illustration (pl. 36) shows a skipway ("A") with steel plates placed underneath to prevent fall of stock on persons below,

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PLATE 36.—SKIP WAY, WITH ATTACHED STAIRS, RAILS, AND STEEL GUARDS.

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and with attached stairway at "B." It also shows railings and housings. The latter were largely introduced a few years ago to afford refuge against the ejected stock which fell at frequent intervals. Recently the valve mentioned on page 201 has been perfected, which, while giving the needed escape for gases, effectually prevents solid matter of any size from escaping. One large company has found that the expense of clearing up the yard in the vicinity of the furnace has been lessened nearly $1,000 a month by the use of this device.

The strain upon the furnace stack of the hoistway and its traveling skips is considerable. At first the added strength of the furnace was considered enough to withstand this strain, but it has been found that such strains in time contribute to irregular action, which may involve the necessity of providing independent supports for the skipways. There is a tendency to make all the parts of furnace tops of greater strength and to provide with more exact care against displacements.

The great change in tops arose from the difficulties attending the early use of Mesaba ore. In the form in use prior to that time the top usually consisted of plates placed horizontally and not very securely fastened. The explosions already mentioned would disrupt such a top at frequent intervals. The shape of the top was changed and in some cases the relief valve was placed upon the dust catcher, the size of the down corners and the dust catcher together with the strength of the top being relied upon to care for the cases of explosion. In recent years the strength factor in furnaces has been greatly increased, with a marked diminution of accidents. For a time the increase in size and blast pressure and other features of "American practice" went beyond the strength of construction. This condition has now been quite generally corrected.

It is necessary, before attempting to discuss other features of blast furnace practice in their relations to safety, to make some further statements regarding the engines and the stoves.

THE BLOWING ENGINES.

The blowing engines are huge air pumps, actuated by steam or gas. The steam blowing engine is nearly always an immense vertical affair, a form of construction enabling a large number of units to be housed on a small area. The gas engines thus far are horizontal acting and require large space. The safe operation of such engines presents no peculiar features. Accessibility to the oiler and the covering of moving parts already discussed apply to these special engines. There is, however, one hazard peculiar to them which is illustrated by the following: In the operation of a certain furnace it became necessary to cut down the blast. The engines were slacked

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up, but not entirely stopped. In a manner not perfectly understood gas from the furnace found its way back into the air cylinders, and an explosive mixture was formed which was ignited in some unaccountable way, the resulting explosion completely wrecking the engine, killing two men and injuring others. The outcome of this disaster was the invention of two valves, one for the hot blast pipe and one for the cold blast, which remain open while pressure is on, but immediately close when it materially lessens. They can be adjusted to close at any desired diminution of pressure, and seem to be an effectual preventive of the passage of gas backward from the furnace to the engine.

To understand the possible occurrence of such an explosion as that mentioned above, some further statements regarding the connections of the engines with stoves and furnace are necessary. The main from the engines divides into branches going to each stove. After traversing the stove and becoming heated the air passes into a pipe called the hot blast which connects with the bustle pipe on the furnace. Besides the pipes from the engines to the stoves, there is a pipe directly connected with the furnace called the cold blast. When it is desirable to lower the furnace temperature, air is taken from the engines through the cold blast. Under ordinary conditions the cold blast is closed by means of a valve. Up to the time of this explosion this valve had been hand operated on all furnaces. It seems probable that at the time of the explosion it was imperfectly closed, and that gas made its way back through it to the blowing cylinders. It is difficult to understand how this could happen, since apparently the engines were in motion, and so a current of air should have been passing toward the furnace. It is also not easy to understand how, even if an explosive mixture were formed in the engine cylinders, it could be ignited. Since the apparently impossible happened in this case, adequate precaution is necessary, in spite of the fact that the exact combination of circumstances producing danger would be very unlikely of repetition.

THE STOVES.

The general appearance of the stoves is shown in plate 33. In the earliest form of these combustion took place around iron pipes, within which the circulating air was warmed. Now the nearly universal practice is to build the interior of refractory bricks, laid in an open pattern, called the checkerwork. Through these the gases from the furnace circulate as they burn. The bricks are thus brought to a high temperature. This heating is taking place in three stoves, while through a fourth air passing from the engines is heated by the incandescent bricks and then goes to the furnace. The general practice in America is to have four stoves, so that each stove is

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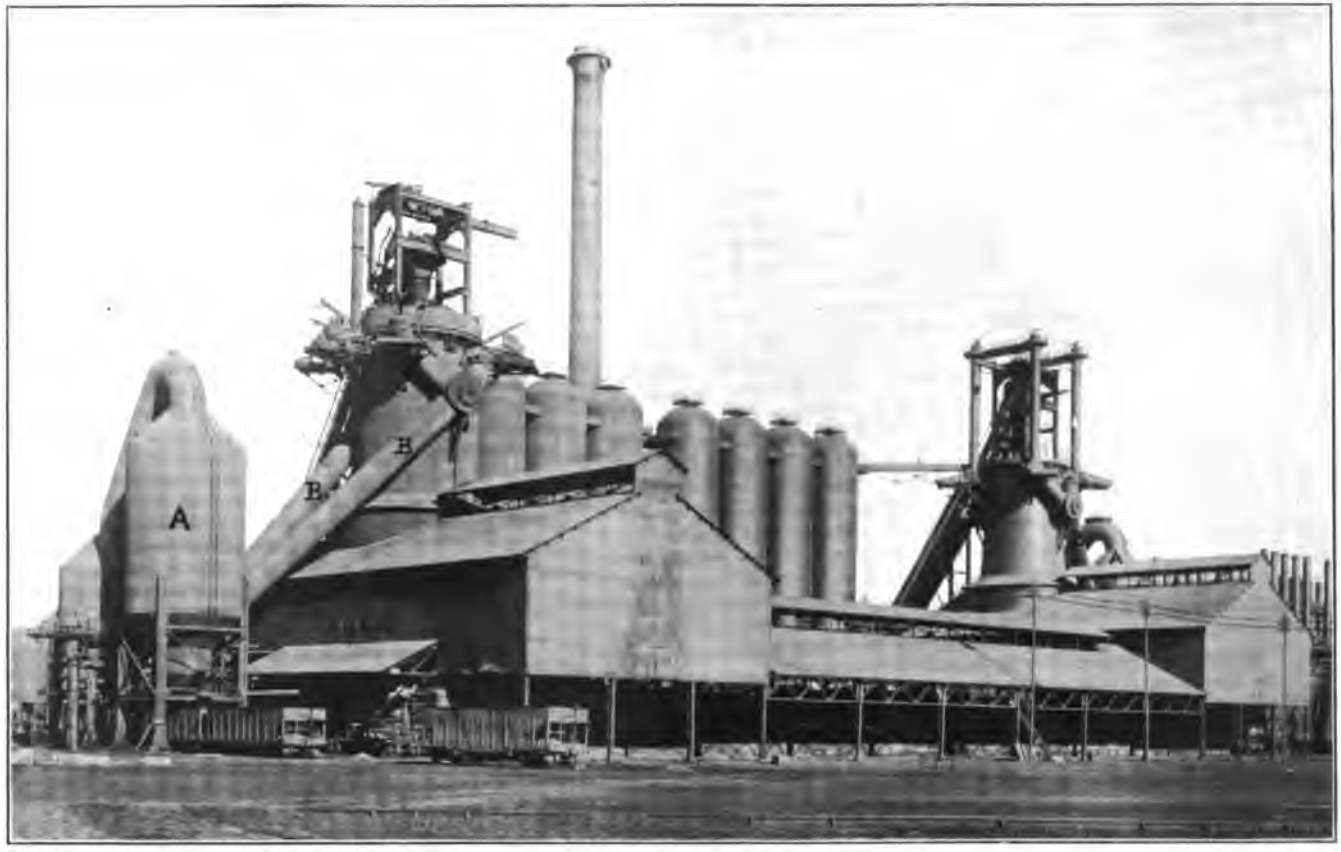

PLATE 37.—BLAST FURNACE, SHOWING DUST CATCHER.

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PLATE 38.—SPRINKLER ON DUST-CATCHER OUTLET.

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heating "on gas," to use the furnace man's term, for three hours and then for one hour delivers the heat to the furnace. In their operation the most pronounced danger arises in connection with cleaning. For this purpose it is necessary to enter the stoves and numerous accidents are on record from suffocating gas, falling bricks, and the accidental turning on of burning gas while men were in the stove.

Some German furnaces have adopted a fifth stove, which can be cleaned independently of the regular activity of the normal number. The precautions possible under present conditions are these: Guarding against gas by very thorough ventilation of the stove before cleaning operations begin; operation from the top until all loose bricks have presumably been detached and have fallen; and the secure locking of gas valves so that they can not be inadvertently thrown into place.

Of more importance than these, however, is the growing practice of washing the gas. As the "raw" gases come from the furnace top they are heavily laden with dust of coke, ore, and lime. For the removal of the coarser portion of this dust the dust catcher, shown at "A" in plate 37, has long been in use. The catcher is in effect a great enlargement of the gas pipes, called "downcomers," shown at "B," which convey the gas from the top of the furnace. The older furnaces have but a single outlet, which tends to favor the passage of the gases toward the side from which the "downcomer" leads. In present practice three or four outlets are provided at the top of the furnace. This increased number of outlets distributed equally about the furnace top contributes to the uniform passage of gases through the burden.

Upon entering the dust catcher the sudden increase in diameter much reduces the velocity of the moving current and at once a very large part of the dust falls. The bottom of the catcher is an inverted cone-shaped hopper. By means of a door the accumulated dust is at intervals discharged into cars placed beneath. Since the dust is red hot it presents serious dangers to those whose duty it is to handle it. Formerly it was dumped into the cars and then quenched with a stream from a hose. This was unsatisfactory, because often below the surface the material was still of a dangerous temperature. In the moving and unloading of the cars serious burns were, and still are, much too frequent. The sprinkling arrangement shown in plate 38 insures that the dust will be in a safe condition to handle.

After passing the catcher the gas is still loaded with a fine dust. The gas can be used in this condition to fire boilers and in the stoves, but this use of partially cleaned gas entails very serious labor in cleaning and subjects the apparatus to an erosive action which may be quite destructive. Such gas can not be used in gas engines. The growing use of this form of prime mover, so economical in its production of power and so appropriate where such quantities of gas

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are available, has led to the extensive use of gas washers. These are of various patterns not necessary to describe but all acting upon the principle of mixing the gas with water, which grasps the solid particles. From the washer two streams proceed, a stream of clean gas suitable for any use and a stream of dust-laden water which is led into settling tanks, from which the accumulated waste is removed.

While perhaps gas washing would not have been undertaken for furnace stoves and boilers, it was a simple matter when providing for engines to care for the entire product. The economies and advantages incident to the application of washed gas to stoves have proved so great that it is a fairly open question whether it would not be a justifiable modification on this account alone. The use of washed gas does away almost entirely with the troublesome and dangerous process of stove cleaning. Whereas with raw gas a stove must be cleaned at least once a month, with the washed material it is not necessary under three or four months. More important than this, however, is a very great increase in possible efficiency. This increased efficiency comes about in the following way: When raw gas is used it is impossible to reduce the size of the opening between the checker bricks below a certain aperture. This is true because the smaller opening would clog so quickly and completely as practically to render the stove useless. With clean gas the opening can be reduced, giving a much greater exposed surface and so favoring both heating and the delivery of the heat. There is also some material advantages in the well-known fact that small units of construction have a relatively greater strength than larger ones.

For satisfactory understanding of the heating process the course of the gases and the air through the stoves is here more fully indicated. Formerly the gas was often brought to the stove by underground conduits, usually of brickwork. These are now replaced in good recent construction by overhead mains of steel lined with brick. The old construction was very objectionable because the gas sewers were rarely gas tight and when they became exceptionally leaky the location and repair was so difficult that it was commonly allowed to go by default. The result was that the porous soil about the furnace would become saturated with carbon monoxide, which, rising from the general surface, would maintain a more or less poisonous atmosphere continuously. This could not fail to affect unfavorably the health of all occupied in the vicinity. This was a serious menace to all blast-furnace workers, and had a material influence upon the accident rate. A superintendent of a large plant states that upon taking charge he was so seriously affected that he was obliged to have a new office erected at some distance from the furnaces. The unpleasant symptoms did not fully disappear until in the progress of reconstruction the underground conductors were entirely replaced.

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PLATE 39.—OXYGEN HELMETS.

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In this connection also may be emphasized the need of careful ventilation of all rooms, such as gas washer houses and gas engine rooms, where the furnace gas is used. It is much more deadly than ordinary illuminating gas and numerous instances are on record of fatal asphyxia in such places.

The development of oxygen helmets for use in mines has an important application at blast furnaces. Plate 39 gives an idea of the appearance of these helmets in use. A cylindrical tank containing compressed oxygen is carried on the back. Great care in inspection is necessary with this apparatus, since the parts composed of rubber are liable to deterioration and even with the exacting care bestowed by the Bureau of Mines cases have occurred of failure at the critical time. With the use of these helmets work can be safely done which would be extremely dangerous without them. Perhaps more important than the helmets are the oxygen cylinders and pulmotors used for purposes of resuscitation.

The gas upon reaching the stove passes into a vertical combustion chamber extending to the top of the stove. As it passes into the chamber suitable quantities of air are permitted to mingle with the gas and it burns with an intensely hot flame. At the dome-shaped top the current of heated gas is deflected downward and passes through the checker work, yielding up its heat as it goes. The checkers are arranged so that gases pass the length of the stove several times and are designated accordingly as "two-pass" stoves and "three-pass" stoves. The gases finally escape either to a common stack or by way of an individual stack for each stove. The escaping gases have a temperature of from 700° F. to 1,000° F., according to the condition of the stove. A newly cleaned stove will cut down the initial temperature of combustion of 1,500° F. or higher to the lower figure. With clean gas this capacity of the bricks to absorb heat remains fairly constant, though bricks of certain qualities become vitreous and lose their heat-absorbing qualities in time. When a new stove is put on at the end of an hour its temperature is, of course, much higher than that of the stove which has just been in use. The temperature of the blast is kept constant by admitting the proper quantity of cold air. This is gradually diminished as the hour goes on, so that the blast may vary as little as possible.

One variable remains to be considered. The quantity of water in the atmosphere varies greatly. On a warm and humid day the amount is much greater than during a cold and dry day. When it is stated that in a day of average conditions 20 tons of water will be blown into and through a large furnace, some idea will be given of its importance. Simply as a useless and in itself somewhat disturbing substance this passage of moisture is to be deprecated. The variations are, however, the source of the greatest trouble. From hour

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to hour the changes occur with an irregularity almost impossible to follow with exactness. It is, of course, possible by varying the blast to correct or counteract in some measure the shifts of humidity. Air of uniform quality is, however, as desirable to the furnace man as a uniform supply of other materials.

A method of securing this, the so-called "dry blast," is in use in a number of plants. It consists, essentially, of an ammonia refrigerating system by which the moisture of the air is condensed and the air is delivered to the blowing engines in a uniform and comparatively dry condition. This assists materially in production, and by contributing to uniformity of action aids markedly in securing safe practice.

MOVEMENT OF STOCK IN FURNACE.

With the stock filling the furnace stack, the engines delivering their proper quantity of air, and the stoves raising this to the desired temperature, the consideration of furnace operations proper may be resumed. It has already been shown how necessary to satisfactory operation is uniformity in chemical and physical quality and in distribution. This is the key to both production and safety. First the stock must move down steadily. The hanging of the charge, due to the deflection of the blast by the unequal distribution of the stock, has already been described. The same result may come about in several other ways. The results in explosion and general disorganization may be just the same.

The usually thick walls of brick are subject to several forms of erosion. When, for example, the blast is diverted into one channel the extra heat softens the lining and a "hot spot" appears; that is, the shell of the furnace becomes heated to redness. A spray of water applied to the spot will often prevent any damage to the shell, but deep interior erosion has no remedy, and while it may choke up to some extent will remain throughout the life of the lining a hindrance and a menace. It tends constantly to reproduce and intensify the irregularities by which it was produced. In the use of Mesaba ore particularly a peculiar phenomenon has been noted. With this ore there is a deposition and absorption of carbon in the upper portion of the furnace which causes a remarkable expansion of the ore. The experiments indicate expansions of from two to five times. This tends to produce what is called "wedging." The expansion occurring more rapidly than the change in diameter of the stack causes pressure upon the walls and interferes with the downward movement. The deposition also tends to make the stock impervious to the gases at the point of occurrence. Both the tendency to hang and the gas stoppage give rise to trouble.

In case a tuyere becomes leaky, as it may from abrasion of the descending stock, weakness due to the spattering of molten iron on

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its projecting end, or an interruption of the water flow within its hollow walls, the portion of the furnace in the vicinity will drop in temperature. This will probably cause a hang of the material above the tuyere, the pasty material solidifying and adhering to the wall. When this adherent mass finally breaks away it is very likely to carry a portion of the brick wall with it. Thus, again, will be formed a pocket in the wall constantly hindering free downward movement and tending to start new hangs.

All these varied and persistent sources of annoyance and danger are hidden from direct observation, and the exact nature of the trouble is often exceedingly difficult to determine. Further illustration of the importance of methods guarding against the causes of irregular stock movement might be multiplied almost indefinitely. The foregoing suffice for the present purpose of showing how closely safety and satisfactory operation are bound up together.

EXPLOSIONS.

Before discussing conditions upon the cast house floor it is desirable to add something to the statements regarding explosions. This is a subject upon which furnace men are by no means agreed, and technical authorities have not yet studied the matter sufficiently to give a satisfactory account of the phenomena. This is surprising in view of the wreckage which has attended the increase of explosions in the use of Mesaba ore and the resulting loss of life.

The case of complete carbon consumption below a scaffold and the sudden union of the uncombined oxygen with carbon when the scaffold broke has already been detailed. One authority holds to the view that the sudden release of the blast would often be sufficient to produce the result. That the force thus applied would be sufficient to lift the column of stock under some circumstances is undoubtedly true. It does not seem at all adequate to produce the furnace wreckage which has gone with the other phenomena. Nothing but an actual explosion will fully explain some of the things which have occurred. The statement that such explosions as those described are really dust explosions is questioned by the experts of the Bureau of Mines, since they have not found coke dust explosive in their experiments. The situation developed in the furnace is one entirely different from that in the experimental gallery. The incandescent dust of the furnace is a much more explosible material than the relatively inert coke dust experimented upon.

One fact of occasional importance has not been found mentioned anywhere—namely, that under some circumstances the ore itself is explosive. The experimental evidence is as follows: Several cars of an ore of unusual appearance reached a certain superintendent's yards one day. It so happened that no storage space was available,

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and the ore was hastened directly from the cars into the furnaces. In a short time serious explosions began, causing considerable damage. In examining the ore to discover the cause of its unruly behavior, a quantity was dried in a pan. When it had reached a certain temperature the pan was accidentally jarred. Immediately an explosion almost like that of ignited gunpowder occurred. Several repetitions of the experiment gave the same result. The explanation is apparently this: The ore was a limonite containing both physically admixed water and chemically combined water. The heating drives off first the free water. At a certain temperature the combined water reaches a critical stage in which it is just ready to escape from combination. If, now, the heating goes on steadily, the dissociation may occur with no disturbance, but a sudden change may cause the water to leave combination immediately. It will then expand to the dimensions of steam with an effect truly explosive. The peculiar circumstances favorable to such an explosion can not be of frequent occurrence, but in all probability some cases which have seemed without explanation were due to this cause.

More common than the explosions just mentioned are those called top explosions or "puffs" and gas main or dust catcher explosions. It has often happened that the very explosive gases generated in "blowing in" have mingled with the air in the upper part of the furnace, in the mains, or in the dust catcher, forming an explosive mixture which has been ignited, the resulting explosion badly damaging the structures. When the furnace is fairly under way and the air has been fully replaced by furnace gases the danger subsides. Whenever the blast is taken off there may be sufficient cooling of the gases in the furnace top or in the receptacles to cause an indraft of air. If this reaches proper proportions and there is contact with the smallest wandering spark or a red heated brick is uncovered by the fall of a portion of the incrusting dust, an explosion will result. A huge dust catcher twisted into an almost unrecognizable mass gave evidence that such explosions are not always small.

An experiment made in connection with an effort to devise means of safeguarding against these happenings showed conclusively that the mixture of air described is possible. A dust catcher was sealed closely, a test being made of the internal pressure. As cooling progressed the pressure gauge went down, until finally it was negative. Since perfect closure was impossible, this negative pressure did not become very great, the air of course gradually filtering in. The best safeguard thus far devised for this condition is the filling of the mains with some inert gas. The most readily available is steam, and by its proper use this class of explosions may be made almost impossible. When several furnaces are operated in a group it may be possible to couple them up in such a manner as to keep the dust catchers con-

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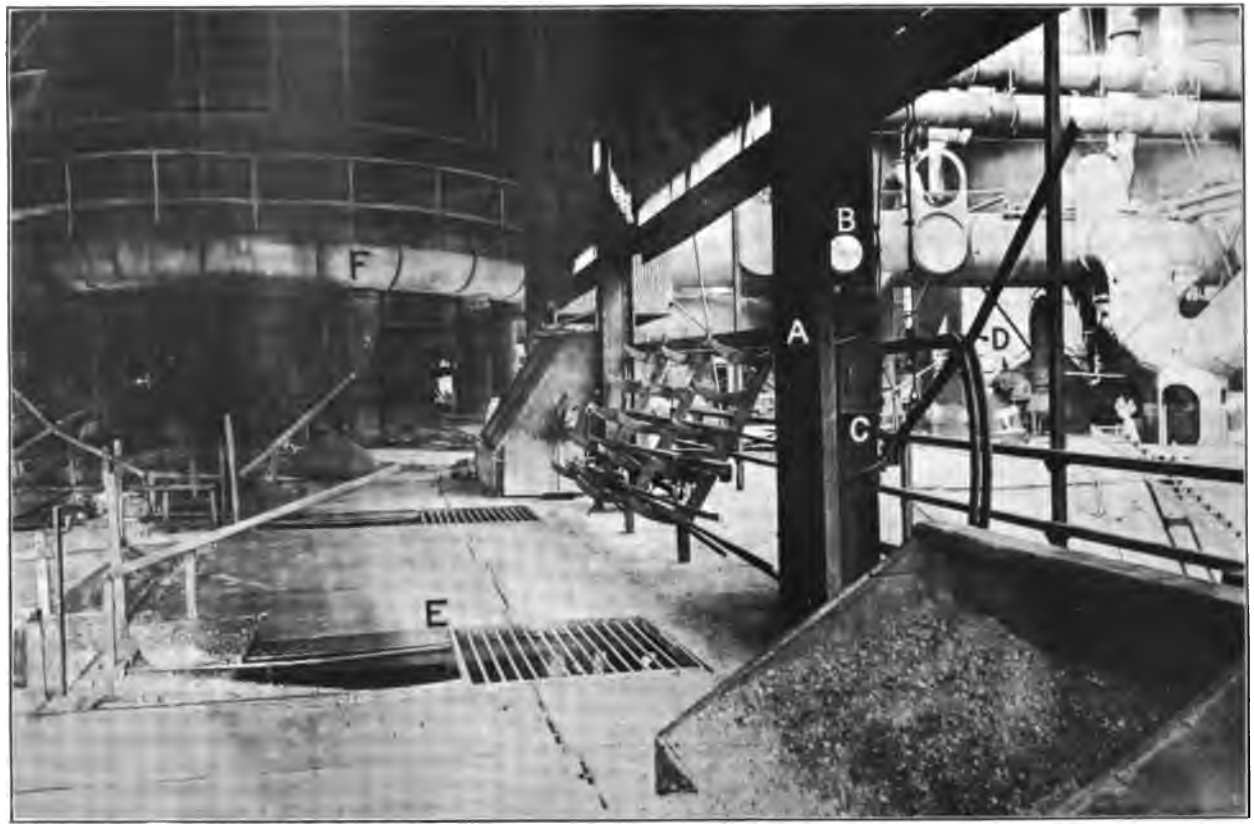

PLATE 40.—PORTION OF CAST HOUSE FLOOR.

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stantly filled with hot gas, thus preventing the cooling and shrinkage by which the intake of air is brought about. In one large plant a combination of these methods has given much satisfaction.

THE CAST HOUSE.

The dangers of the cast-house floor will now be considered. The cast house surrounds the stack, a small portion of it extending to the back or skip side, while the larger portion is on the front or casting side. The side walls are brought down far enough to prevent storms from beating in, but do not reach the ground, since free ventilation is absolutely necessary. All recent furnaces are built at a considerable elevation above general yard level for convenience in running off the molten iron into ladles or loading pig onto cars.

Plate 40 shows a portion of a cast-house floor. At the right, sheltered by a screen ("A"), is a dial ("B") and a box containing an electric switch ("C"). The lever "D" with a rope extending upward can also be operated while protected by this screen; this lever connects with the "snort valve," by means of which the blast may be taken off the furnace without stopping the engines. The importance of permitting safe operation of these means of communication and movement will become evident a little later. In the furnace of which this is a picture the ladle cars are run under the floor. The grated opening in the foreground at "E" marks the point at which the iron runs into the ladle. In the background is the furnace stack with the bustle pipe ("F") extending around it.

An infrequent but most serious peril of the cast-house workers has been the "break out." The lining of the furnace is subject, as has been explained, to constant wear by heat and by the movement of the contained materials. If this wear occurs in a sufficient degree below the level to which the molten iron accumulates, the hearth jacket may be melted through and a sudden flood of metal be poured out. In one of the worst disasters of this kind which came under notice during the investigation there was apparently an explosion at the same time. It so happened that a number of men not usually employed there were passing through the cast house at the time. To this fact is attributable the large death list, numbering 14, with others seriously injured.

The remedy for such occurrences lies along the lines of extreme care in operation, which have been discussed, and in increasing the factor of safety in the strength of the furnaces. One large plant which has recently undergone reconstruction almost completely has had no such occurrence for four years, whereas with former construction no year passed without one or more. Furnaces now constructed have a degree of strength which the furnace man not long ago would

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have thought wholly unreasonable. A further factor of safety in recent construction is much more effective water cooling of the hearth jacket. With these improved arrangements a dangerous heating of any portion of the hearth is at once reported by the higher temperature of the escaping water and can be corrected by an increased flow. In the older furnaces it was not uncommon for the iron to burrow through the bottom and form huge masses called "salamanders" in the underlying soil. These formations were usually attended with little danger, but might at any time break out upon the surface, and if any dampness was present a serious explosion would be likely to occur.

Before passing to the consideration of the operative dangers of the cast house, brief attention should be directed to a new form of construction which has interesting possibilities both for safety and production. It has long been the plan to protect the walls of the bosh by means of bronze cooling plates in which water circulates. These are sometimes placed in the stack walls above the bosh for a certain distance, this being a point where from the changing direction of the walls erosion is particularly liable to occur. In a few cases these plates have been put in place as far up as the stock line. Recently furnaces have been erected having linings of 9 to 12 inches for the stack instead of the usual 60 to 72 inches. The outside of these stacks is provided either with an arrangement for spraying water over the entire surface or is inclosed in a series of water jackets through which the water passes downward. The idea of the designers of these furnaces has been that the thin lining, with the possibility of preventing overheating at any point, would exactly preserve its original lines and so avoid the troubles arising from lining erosion. This hope has been fully realized, one furnace of this type showing a change in internal diameter at the bosh line of only one-half an inch during a run of six months. The difficulties arising from differential chilling remain and are perhaps more pronounced than in the older types, and new difficulties arise from the liability of the cooling water to find entrance to the stack. Opinion among those now using these new designs is rather divided, and until the trial has proceeded further it will be impossible to estimate the influence of these new features upon safety.

In regular operation the discomforts and dangers of the cast-house gang center about two items, namely, tapping cinder and tapping iron. The "cinder notch" is at one side of the furnace, about 30° removed from the "iron notch," from which the metal is taken. The cinder notch is at a higher level, and from it the slag can be drawn off without disturbing the iron which lies below. The slag can rise nearly to the level of the tuyeres and must then be tapped off. It is very apt to fly and inflict serious burns upon the "cinder

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PLATE 41.—CINDER NOTCH, WITH GUARD.

PLATE 42.—MUD GUN IN POSITION FOR CLOSING TAP HOLE.

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snapper" when he opens the notch. Guards of various forms are provided for this purpose. One arrangement which appears to be among the most satisfactory is shown in plate 41. Other forms of protection were noted differing somewhat in design.

The slag thus tapped off flows down a runner either into a slag ladle or a granulating trough. Both in transportation and at the slag dump these ladles have been a serious menace. The hot glass which they contain flies more readily than the metal and the accumulations at the cinder bank have presented dangers from crusting over and later breaking through. Until very recently the slag has been almost altogether a waste product simply accumulating in huge piles in the vicinity of furnaces and giving constantly increasing expense in handling as the distance of transportation necessarily increased. The dangers of such dumps may be illustrated by the following: In this case the material was not all slag but included some boiler-house wastes. These contained some unconsumed coal which finally took fire from the heat of the slag dumps. The fire burrowed under the surface and appeared from time to time in smoke wreaths and outbursts of flame. Whenever this occurred the bank foreman caused streams of water to be directed into the openings to check down the fire. No danger was apprehended and both foreman and other workers crossed the dump as their duties might require. Finally a worker on night turn crossed an area which the foreman had not long before traversed in his regular round of inspection. The fire had evidently worked underneath until the crust was too weak to sustain a man's weight. The worker fell through and before he could be rescued was fatally burned. The case is not strictly comparable with conditions on a cinder dump, but is so similar as to illustrate what may possibly happen.

The difficulty of such disposal from another viewpoint is illustrated by the experience of the company in question in endeavoring to remedy the dangerous condition of which this fatality made them aware. In efforts to subdue the fire and get rid of the dangerous material more than $10,000 had been expended without complete success. In a few cases where plants are near river banks excellent retaining walls have been made by the pouring of the hot slag.

None of these methods were wholly satisfactory. Finally came the discovery of the usefulness of the cinder as material for the manufacture of Portland cement. For this purpose a granulated condition has been found most favorable. The granulation is brought about by a very simple method. Behind the falling stream of slag a pipe is brought from which is discharged, under suitable pressure, a stream of water. This both breaks the slag up into granules and cools it to a relatively harmless temperature. The granulating tanks are commonly of concrete and of such shape that they can easily be

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emptied into cars by means of a grab bucket and hoist. Where the material can not be used for cement it is excellent for fills and other similar purposes. Thus a troublesome waste material has been converted to use and its handling robbed of its dangers.

At longer intervals than the tapping of cinder the iron must be run off. From four to six casts are usually made in the 24 hours. When the time approaches for tapping, the keeper and his helpers drill out the indurated clay which fills the iron notch or tapping hole. In most plants six or eight men grasp the drill rod and by sheer force of muscle drill out the clay. Various forms of protection have been used to prevent the outrushing iron from flying upon the men. Recently some plants have adopted the plan of manipulating the drill by compressed air. When this is done two men suffice for the operation, very materially lessening the hazard of burns. Since at least 20 per cent of blast-furnace accidents are burns this is important.

As the iron comes boiling out the various helpers direct the streams into proper channels. Near the tapping hole is a depression in the runway above which is adjusted a heavy iron plate called the skimmer. The heavier iron plunges under this, while the lighter slag on the surface is turned aside into the channel which comes from the cinder notch. At various intervals runner gates divert the flowing metal into different channels. Formerly, and in many cases still, these gates are semicircular plates of iron with a short handle. The worker was obliged to approach the molten stream and with all possible haste dump the gate in the proper place. The extreme heat and the danger of flying metal made this a very trying operation. At present in all the better cast houses the gates are operated either by levers or by cables at a sufficient distance to much reduce the fierce heat and lessen the danger of burns from sparks.

Before considering further the conditions of the cast house floor which call for remedial measures, two possibilities should be noticed. It may happen that the erosion of the lining of which mention has been made occurs near the iron notch. If this is the case there is extreme danger that a "break out" may occur during the process of tapping. It is obvious that in such a case the group of six or eight men crowded in front of the notch will be in grave danger. Several such cases are included in the records gathered during the investigation. In one case four of the group were killed and all the others were more or less seriously injured. It is possible to lessen this danger by greater strength of construction and the water cooling of the hearth, and the use of the air drill above described greatly lessens the number exposed.

Besides the possibility of tapping hole "break outs," moisture in surprisingly minute quantities is a serious menace. To illustrate, during a cast a helper desiring to use a runner gate observed that

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water had splashed upon it. To remedy this condition he proceeded to hold it over the stream of glowing metal. The weight is considerable, and for a moment he allowed the gate to sag so much that a corner touched the stream. A violent explosion at once occurred, scattering a considerable quantity of metal, severely burning the man who was holding the gate and injuring several others.

There are two distinct classes of molten metal explosions—(1) those due to moisture, and (2) those due to occluded gases. Those occurring in ingots and under other conditions where moisture can not have any relation and where the cause must be related to the occluded gases will be discussed later. The chemistry of those due primarily to moisture is obscure. In all probability under the sudden application of intense heat there occurs both a dissociation of the elements of water with an increase in volume incident to this chemical change and at the same time an immense expansion of each resulting gas due to superheating. The result is an expansive violence altogether beyond that ususally associated with the formation of superheated steam. Similar explosions in foundries will be illustrated and discussed at a later point. The occasional effervescence or sparking of the stream of iron productive of some small burns seems to be due to the action of the occluded gases.

In the handling of the iron upon the cast house floor two methods are pursued having some points of individual danger. The formerly universal method conducted the streams of metal into longitudinal channels, the so-called "sows," from which extended the short lateral branches, the "pigs." With this method there had to be accommodations under the roof for the full quantity of a single cast. Spread out as this was over the floor, half being used at one time, the situation was one of almost intolerable heat, with constant exposure to flying metal from the various causes enumerated above.

As soon as the cast was completed, the cooling by throwing on sand and drenching with water began. Clouds of steam filled the house, obscuring the vision of the men and drenching their clothing. When the iron was cool enough the iron breakers with heavy sledges began the severe labor of detaching the pigs and breaking the sows into similar lengths. As this progressed the carriers came on and picking up the yet heated and steaming metal carried it piece by piece to the pig yard piles or to the cars, a hot, heavy job, not particularly hazardous, except as the heavy pigs might be dropped, but the chance of damage from the general conditions of work was by no means inconsiderable. Mechanical breaking and the handling by magnets are coming into use to ameliorate the condition where floor casting seems still desirable.

The channels used to convey the metal may be formed in sand, having in that case to be renewed after each cast, or they may be of

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permanent iron. The latter are called "chills" from the effect which they have upon the iron cast in them. Since foundries still demand sand cast iron the use of that more laborious and dangerous method continues and probably will for some time. Much the larger quantity of iron is now run off the floor into immense bucket-shaped receptacles called ladles, which have already been described under yard practice. The name is now inappropriate, but survives from the form of vessel originally used for hand transportation of molten metal in foundries.

Two items have led to the change in usage in handling metal at the furnaces. First and most important has been the rapidly extending practice of taking the still molten metal immediately to the steel-making processes, and second, the introduction of pig machines. The economy of "direct metal" is very obvious. It will also appear as the discussion proceeds that while some new hazards are introduced the general risk is considerably lessened. To make possible this direct transport of the metal, furnaces were further elevated so that the ladle cars could be brought to the edge of the floor or run into tunnels underneath. In the illustration (pl. 40) the grated opening at "E" leads from the floor into such a tunnel. It will at once be evident that in this case there is no widespread area of hot metal for possible explosions, and that the metal received into the ladles is confined in a way likely to prevent scattering about dangerously. The heat of the cast house also is much less since only the surface of the runners necessary to convey the metal is exposed and the ladles when full are at once taken away. With the elevation of the cast house floor came a need not always promptly and properly met for railings to prevent men falling and for easy ways to escape in case of disaster. The screening of operating switches and levers has already been mentioned. In new construction these needs are being fully met, and in many cases the older furnaces have been much improved.

After the iron has been drawn from the furnace the tapping hole must be closed again. This was formerly accomplished by the clay men throwing balls of clay into the opening, which were then tamped into place with a bar. The very general practice at the present time is to use an apparatus called a mud gun (pl. 42). Clay balls are introduced into the funnel marked "A" and forced into the tapping hole by the action of a plunger actuated by steam. The apparatus shows several modifications conducing to safety, which are not in universal use. For example, a clamp "BB" holds the gun firmly in place so that it can not "kick back." At first the opening for the introduction of clay had no funnel-shaped guard and several times in endeavoring to get the clay into the gun a hand or foot was injured. In earlier forms the steam connection "C," which in the illustration is of

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metal pipe with swinging joints, was formed of rubber steam hose. This was liable to deteriorate and burst, scalding the workers. This apparatus illustrates the step by step development of a complete safeguard.

THE PIG MACHINE.

The final item of blast-furnace equipment calling for special mention is the pig machine. This is most frequently used where the steel-making methods are operated intermittently and some provisions must be made to care for the constant output of the furnaces. The most successful type of this machine seems to consist of an endless chain upon which iron molds are mounted transversely. At one end of the structure these molds coming up from the underside are filled with iron as they pass. As the chain carries them forward the pigs in the molds are cooled by water sprays, or sometimes by being carried under water in a trough. At the end of the structure, as the molds are carried over to the other side, the pigs fall out onto a pile or into a car. As the molds pass backward toward the pouring end they are sprayed with a limewash to prevent the pigs from sticking.

The records show three dangers in the operation of these machines: (1) Explosions at the pouring end. These are mainly due to moisture, and the only safeguard seems to lie in an increasing vigilance and in roofing over and inclosing the operation of pouring. (2) Uncovered gears. (3) "Stickers." These are pigs which fail to drop out at the turn. These may fall later, or may have to be pried out. In case a passageway exists under the apparatus, it may be roofed over to prevent stray stickers falling on those below; to provide for those which must be pried out some means of access is necessary in order that the operation may be conducted safely.

The product of the furnaces is nearly always spoken of as "pig metal" even when molten. "Direct metal" and "hot metal" now often designate the molten material taken at once to the purifying processes. Pig iron is a very impure substance. It is both an alloy and a mixture. For castings of various sorts it may be used by melting and pouring into molds. The vast majority of present uses, however, require that it be further purified and its composition determined by the exact introduction of other elements.

PUDDLING.

This is the oldest of the purifying processes. In fact, the old "bloomaries" which made iron direct from the ore depended upon the same principles. The apparatus consists essentially of a furnace having a large fire box at one end, the flames from which are reflected upon the pig iron placed in an adjacent chamber. As the mass liquifies the puddler "rabbles" it vigorously with a hoe-shaped iron.

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As the impurities are burned out, the melting point rises and the metal solidifies in small masses. These are gathered into two or three "balls" by the manipulations of the puddler. When ready, these are removed and hammered or "squeezed" to remove the slag. The hammering, or "shingling," as it is called, produces much the best iron. All these processes are very laborious, and only vigorous men can undertake the work. There is no great hazard, a minor burn occurring now and then and an occasional spark flying in the eyes. On the whole, the puddlers' occupation can not rank with the hazardous occupations of the industry. In the first section of the report will be found some account of the few changes which have tended to modify the severity of earlier conditions. Since the hours have never been very long, these conditions have not been so serious as in other departments.

THE BESSEMER PROCESS.

On the successful development of the Bessemer process hung for a time the growth of the steel industry. By it for the first time large quantities of steel could be produced with a reasonable expenditure of time. The fundamental element of the process is the converter, an egg-shaped steel shell lined with refractory material. Through the hollow bottom the blast is blown. The converter is suspended on trunnions and can be tilted in either direction; when in a horizontal or inclined position quantities of molten metal can be poured in from a ladle.

A danger of this process is illustrated by the following: A small car with a ladle of hot metal had been drawn into place in front of the converter. A hook by which the ladle was tipped in order to pour had been attached. At this point a vessel man noticed that a "skull" of cooled metal had formed upon the nose of the converter. He signaled to have other operations suspended and proceeded to remove the skull by the use of a sledge. It at once became apparent that the car and ladle were much in the way of this operation. The man in charge signaled to have the car withdrawn, but forgot to detach the hook before mentioned. As the car moved the hook drew, tipped the ladle, and a stream of hot metal poured over the man working upon the vessel, with instantly fatal results. A simple locking device now makes it impossible to shift the car from the pouring position without first detaching the tilting hook.

Many cases of accident are recorded from the falling of the heavy pieces of scrap, such as crop ends of blooms, old rails broken up, etc., which are put into the vessel when upright. To avoid these, two devices are in use. A warning bell is rung when the scrapping process begins, so that those below may get into places of safety, and chutes of improved form are provided from which the masses of

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scrap are less likely to jump. To illustrate various devices, a description of a plant in which they are installed will best suffice. These devices are not all to be found in any one plant, but have been observed in different places.

If the hot metal is transported directly from the furnaces, it is in most cases delivered to a mixer. These are bowl-shaped receptacles holding from 100 tons upward, adjusted so that they can be tipped to pour out the metal. They serve, as their name indicates, to mix the product of several furnaces, thus equalizing the quality and keeping the metal in molten condition during the delays incident to changing bottoms, patching the bottoms, and occasional more protracted repairs. The mixers, being adjusted to tilt, have been in some danger of oversetting if the power by which they were managed should give out. This has been guarded against in three ways: (1) By counterweighting, so that on failure of power from any cause the reservoir returns to a horizontal position; (2) by an electrically actuated dog which in case of mishap locks the mixer so that it can not move in either direction; (3) by a safety valve operated by the man in charge of the hydraulic tilting apparatus. The impelling cause of the invention of this safety valve was the oversetting of a mixer when the handle of the operating valve broke, making it impossible for the men in charge to reverse at the proper time. The mixer, of course, tilted to the full limit and poured out its entire contents.

Wherever hydraulic power is used the safety valve may be applicable and is so effective a device that it deserves further description. A mixer is handled by means of two hydraulic cylinders placed in opposition to each other below the bowl-shaped reservoir which contains the metal. These are called the pouring cylinder and the righting cylinder. A valve admits water to these cylinders according to the position in which it is placed by the operator. Obviously danger arises when by leakage or failure of this valve it becomes impossible to prevent the passage of the water into the pouring cylinder. The safety valve operates as follows: From the line of pipe leading to the pouring cylinder a pipe is led to the sewer. It runs under the platform on which the operator stands. In this pipe is a valve, counterweighted, so that ordinarily it stands open. In this condition no pressure can be conveyed to the pouring cylinder. Through the floor just beside the station of the operator projects a rod expanded at the top into a foot plate. When the operator wishes to pour he must first depress this rod with his foot, closing the safety valve. If anything goes wrong with his operating valve he has only to remove his foot from the foot plate, the counterweight causes the safety valve to open, and pressure is at once taken off from the pouring cylinder. Since the valve ordinarily stands open, leakage of

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the operating valve can not produce pressure in the pouring cylinder. The necessary constant use of the safety valve in connection with operation insures that it will be in good order, which is not always the case with apparatus which comes into use only in case of emergency.

The metal is carried from mixer to converter in various ways. A ladle crane is most frequently used. The ladles in this case are not so large as those used in bringing metal from the furnaces, but the quantity is sufficient to cause serious danger to the craneman in case of a spill. This may be guarded against by a gallery outside the building to which he may escape, or perhaps better by a special heat-proof chamber. The most satisfactory arrangement of this chamber is a metal box, asbestos lined, with automatic doors through which the craneman may easily pass and which will promptly close behind him. Some of the earlier forms of this safety chamber were imperfect in that they were not provided with appliances for operating the crane. The recent installations have a controller within the chamber and properly protected peepholes, so that the craneman, having secured his own safety, may so operate his crane as to save property and perhaps life.

When the metal is brought to the converter by the crane or car the dangers concern two items particularly: (1) The method of pouring and (2) the possibility of explosion. Careful design and thorough and frequent inspection are the principal safeguards for pouring. Fortunately, explosions are rare, but when they occur loss of life is almost certain. The cause of these explosions is obscure. The normally occluded gases of the molten metal sometimes produce them; in other cases contact with external moisture is responsible. One of the most serious explosions disclosed during the course of this investigation apparently arose entirely from the moisture upon a large piece of scrap which was thrown into the converter. The only possible safeguard against this danger is extraordinary care that moisture be kept away from the molten metal.

Treatment in the converter being completed the metal is poured from the converter into ladles carried upon jib cranes as shown in plate 43. Little danger is connected with the operation of these cranes if due care is taken not to overfill the ladle. When that occurs the pitmen below may be seriously burned by slopping metal. The crane operated from the blower's platform swings around and rises to the level of the top of the molds which can be seen in the illustration at "B" standing upon their cars. When in position the steel pourer opens the valve in the bottom of the ladle and fills the molds in succession. The dangers of the steel pourer and his helpers arise mainly from a defective stopper which may fail to shut off the stream of metal when desired and from the chance that the crane will allow the ladle

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PLATE 43.—LADLE CRANE IN BESSEMER PLANT, WITH SAFETY DOG ON HOIST.

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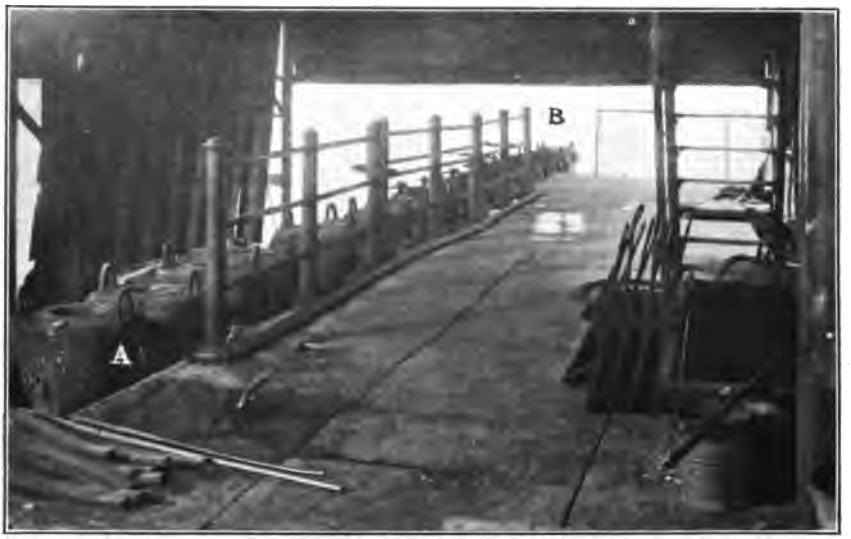

PLATE 44.—INGOT MOLDS, WITH RAILING FOR PROTECTION OF UNCAPPERS.

PLATE 45.—WET MIXING PAN FOR GRINDING GANISTER.

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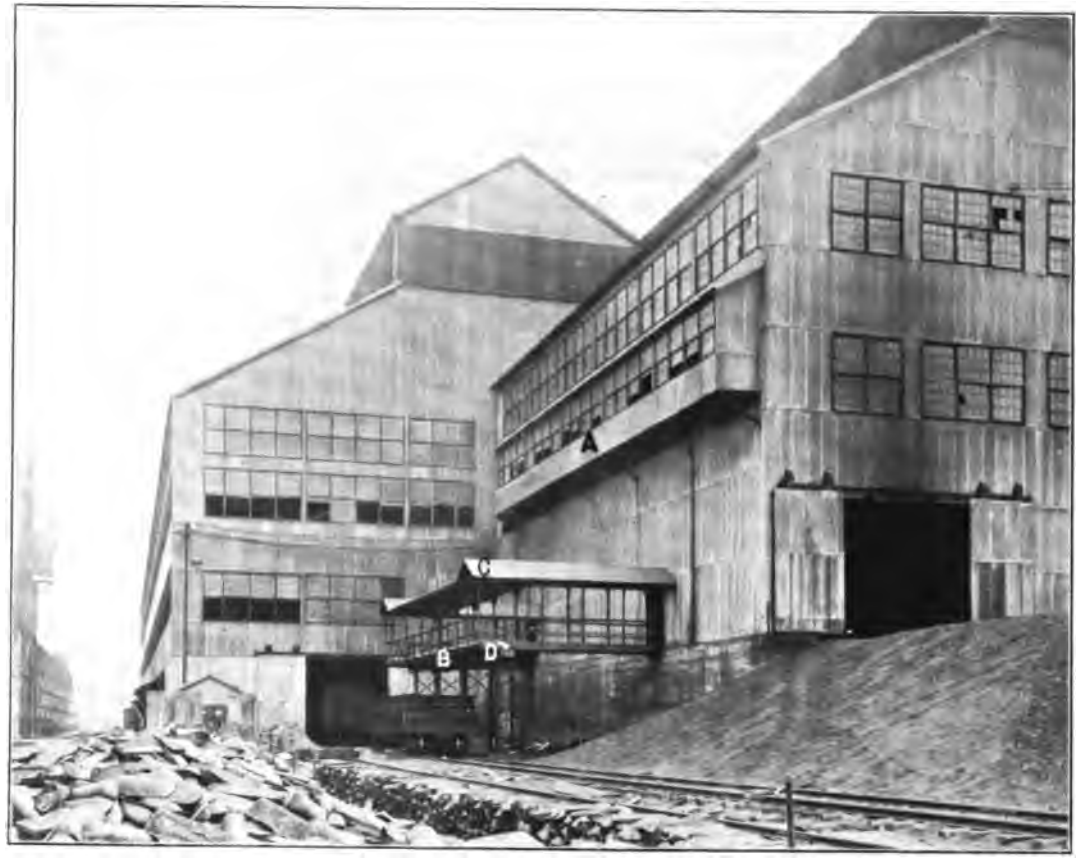

PLATE 46.—OPEN HEARTH BUILDING.

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to settle down, strike the top of the molds, and so be overset. As a protection against the first danger one plant has arranged two air hoists above the pouring platform and by one of these the stopper is removed when the ladle is empty. The stopper withdrawn from the preceding ladle is then lowered into place, provided upon inspection it appears to be in good condition; otherwise a new stopper is used. This, it will be noticed, is simply providing a means for sufficiently frequent inspection to insure safety. The life of the stopper is also somewhat prolonged by this method. The failure of the crane mechanism is provided against in the plant shown in the illustration by a device the location of which is indicated at "A," but the method of operation of which is not apparent. It consists of a catch or dog which falls into place whenever the crane rises to a point above the level of the top of the molds. The only way in which this catch can be released is to swing the crane laterally far enough to clear the molds. This effectually prevents, even if the hydraulic cylinder should entirely fail, the lowering of the ladle upon the molds.

In making soft steel it is the usual custom to place an iron cover on top of the mold. This may after a short time be removed. When this is done it often happens that an explosion occurs which may seriously injure the uncapper. Screens of various sorts have been introduced for his protection. A simple and effective device is shown in plate 44. It is a railing upon the edge of the platform which prevents taking off the caps until the steel is cool enough for this to be done without danger.

Among accessory operations about the Bessemer plant the grinding of the ganister for converter bottoms has some dangers. The grinding apparatus consists of a horizontal revolving disk of stone upon which roll vertical stone wheels. Formerly the feeding and removal of the material was accomplished by the bottom house men with shovels. The arrangement shown in plate 45 makes near approach with its accompanying danger needless. A hinged portion of the stationary rim at "A" is forced in by hand wheel and screw "B." "A" cuts into the revolving wet material which is forced out into the wheelbarrow. The apron plate at "C" prevents a man from catching his fingers between the revolving pan and the stationary rim.

OPEN HEARTHS.

The reception of the metal at the mixer differs in no particular from that already described for the Bessemer process. Plate 46 shows a recently built open hearth with an outside gallery ("A") for the escape of the craneman in case of a spill, a covered gallery ("B") for loading refuse into cars protected by a roof from snow or icicles falling from the adjacent building, and a warning sign ("D").

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The metal from the mixer is conveyed to the furnaces by two methods. The ladle with its load of metal may be lifted by an overhead crane and carried along just in front of the furnaces to the desired point. This is at present the most common method. It has the disadvantage of severely straining the crane and the long overhead transit of the ladles of molten metal has many elements of danger. In the most recent construction the building is made wider and a hot metal track runs along the charging floor on the side away from the furnaces. The ladle is brought on a car to a point opposite the furnace which it is desired to charge. The crane then lifts the ladle and carries it across the width of the floor. After the molten metal has been poured into the furnace, the ladle is returned to its car and drawn from the building. Since in this case an outside gallery for the cranemen would be very difficult to provide a safety chamber is attached to the crane cab, shown in plate 47 at "A."

Next to the transport of hot metal the most serious dangers of the charging floor are in connection with the movements of the charging machine (pl. 48). This is moved by electricity up and down the floor. Upon the machine is mounted a car which carries a great beam, at the end of which, next the furnaces, is a clamp. On a track in front of the furnaces stand cars loaded with boxes filled with scrap. Under the control of the operator the clamp at the end of the beam grasps one of these boxes and when the furnace door is opened the transverse carriage moves forward and pushes the box into the furnace. When the box is entirely within the furnace the operator pulls a lever and at once the beam revolves and the contents of the box are dropped into the bath of molten metal. A machine of such size and with so many movements has dangers in its use. The illustration shows at "A" how the gears are covered, and at "B" how the wheels are guarded. An automatic bell is used to give warning when the machine is moving from place to place on the floor, but does not appear in the illustration.

On the tapping or pit side of the open hearth the danger of falling from the platforms, from which the handling of the iron runners and other items of the process of tapping are carried on, is provided against by suitable railings and guards about the machinery.

A frequent cause of injury is a premature breaking out of metal at the tapping hole. No mechanical safeguard is possible, but particular attention to the condition just when a tap is to be made and requiring the man in charge to wear suitable clothing if there is any sign of danger has much reduced the number of severe burns.

On the pit side the metal must be conveyed in ladles by means of cranes. These ladles are even larger than those used on the stocking side. Their strength and that of the cranes which handle them is therefore of the greatest importance. The illustration (pl. 49) shows

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PLATE 47.—SAFETY CHAMBER ON OPEN HEARTH HOT METAL CRANE.

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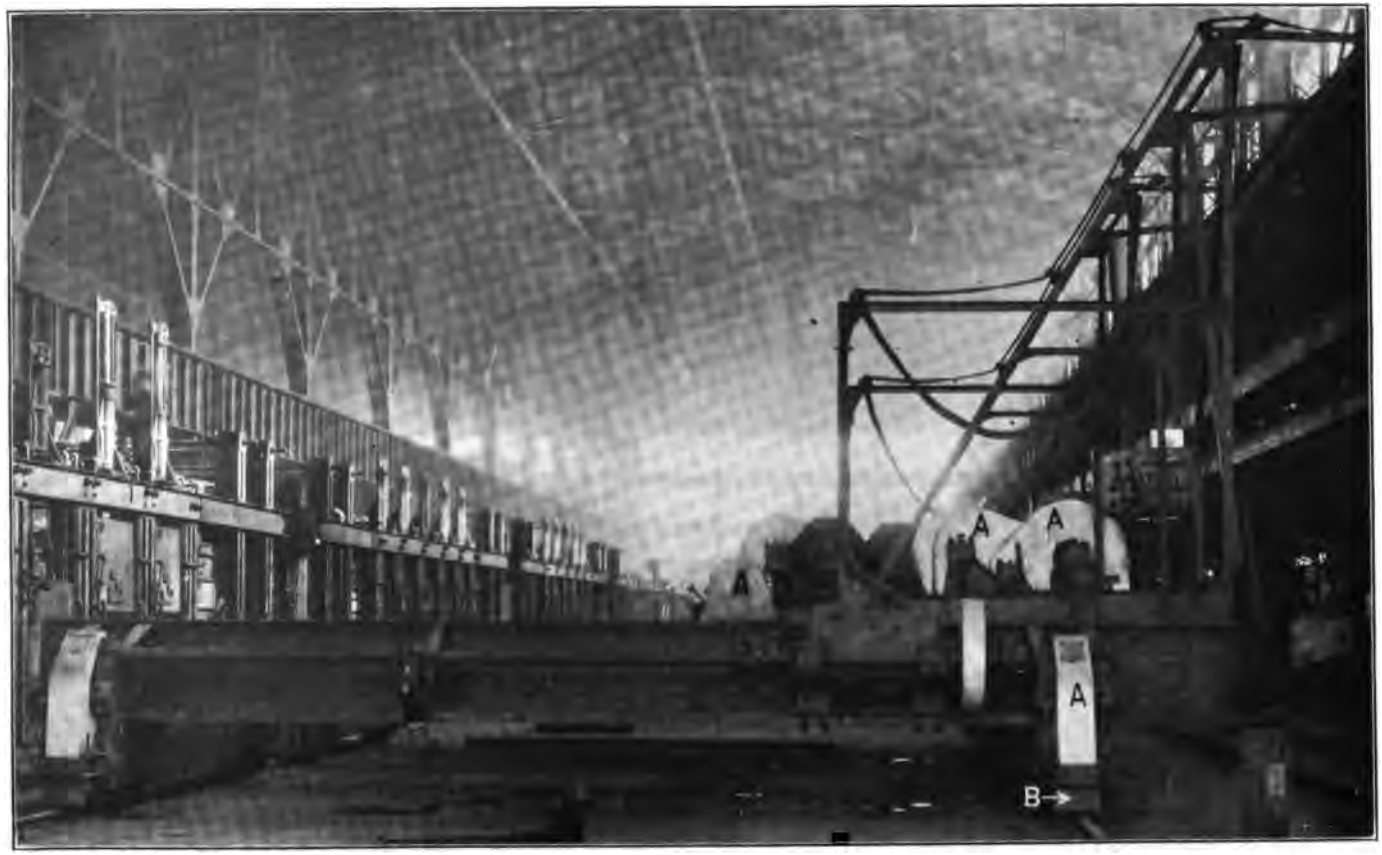

PLATE 48.—OPEN HEARTH CHARGING MACHINE.

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PLATE 49.—OPEN HEARTH LADLE, WITH SAFETY LATCH ON TRUNNION.

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PLATE 50.—PIT SIDE OF OPEN HEARTH, FROM POURING PLATFORM.

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a test of the crane and also a locking device ("A") by which the danger of oversetting the ladle ("B") is greatly lessened.

Plate 50 includes various features of the "pit" side of an open hearth. This name is a survival of an earlier condition when the tapping and casting were done in a pit below the general ground level. In the illustration the view is from the pouring platform ("A"), above which is an escape platform ("B"), by which the craneman may leave his cab in case of a serious spill. The steel pourer and his helpers can jump from the open back of their platform. At the edge of the pouring platform may be seen the tops of the molds ("C") standing upon their car upon the pouring track. Beyond the tracks upon the pit floor are the backs of the furnaces with the railed platforms ("D") about the tapping holes and the runners ("E") by which the metal is led out into the ladles ("F"). When a ladle is filled, it is lifted by the crane and carried to one of the pouring platforms along the opposite wall of the building.

A measure tending greatly to safety and comfort on the stocking side of the furnaces is the provision of water-cooled doors and door jambs upon the furnaces. It was found by experiment that at a distance of less than 2 feet from a water-cooled door a thermometer did not register more than 105° F., while 4 feet from a door not so cooled there was a temperature of from 125° to 130°.

ROLLING MILLS.

In preparation for the rolling mills the ingots produced in the steel works are first taken to the "stripper." This is usually a separate building, though sometimes the stripping is done by a crane in the open air. The stripping crane consists essentially of a vertical plunger to the lower end of which a pair of jaws is attached. These jaws, when lowered, grasp the ingot mold by lugs on each side of the top. As the mold is raised a central piston presses down upon the top of the ingot. This quickly loosens the mold, which is lifted off, leaving the ingot standing upon the car. The mold is carried aside and placed upon another car on an adjacent track. The stripped ingots, gray at the corners but dull red at the sides, are drawn away by a locomotive and taken to the soaking pits. These are gas-heated pits into which the ingots are lowered and in which they remain until the central portion has become solid and the mass is uniformly heated throughout.

In the older method of handling the ingots by an ordinary overhead crane it was necessary to guide the mass by means of long-handled tongs. This was very dangerous. With the newer soaking pit cranes a vertical plunger with jaws at the end comes down and grasps the ingot, the entire operation being controlled by the craneman. His work is very hot and exhausting, and commonly he is

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spelled by having one man more than the number of cranes, as, for example, four men for three cranes.

Warning bells are used on these cranes and also on the cars by which blooms and billets are carried from the reheating furnaces. Plate 51 shows such a warning bell ("B") upon a bloom car and a warning sign at a point "A" where workmen sometimes cross the tracks.

The rolls themselves need guarding in various places, but particularly where the revolving ends of the rolls called "wabblers" are exposed (pl. 52) or where the rolls are connected to each other or to the motor by revolving shafts, called spindles. At "B" is shown the cast-iron floor plates over the scale pit.

The transfer tables, which both bring the metal to the rolls and carry it away, are commonly actuated by bevel gears. These may be entirely inclosed (pl. 53) and run in oil, a very satisfactory and economical practice, or they may be screened by plates, shown in plate 54 at "B." This illustration shows also a bridge ("A") by which workmen may pass from one side to the other of the mill without danger either from the gearing or from the passing masses of metal.

The hotbed upon which the finished rail or other product was placed while cooling was formerly a place of many accidents. With the adoption of better mechanical means of moving the material on the beds and of crossing ways for passage from side to side (pl. 55) the dangers have been greatly lessened.

WIRE MILLS.

The process of wire drawing appears from the records to have one serious danger peculiar to itself. The rods produced in the rolling mills are placed upon large spools or reels from which the rod is carried through the drawing block and thence to another reel which revolves, drawing the rod through the block. This process is repeated until the size of wire desired is reached. It frequently happens that in passing to the block the moving wire becomes tangled, and in this tangle the operator is caught and drawn toward the block. Unless the machine can be stopped the workman is likely to be seriously injured, the loss of a hand or a foot being often recorded. To guard against this possibility an automatic stop (pl. 56) has been introduced. The tangling occurs just when the coils of wire leave the reel. One of such size that it would pass through the ring at the upper end of the lever ("A") would not be dangerous. Those of larger size pull the lever forward and stop the machine. This has proved to be an effective safeguard.

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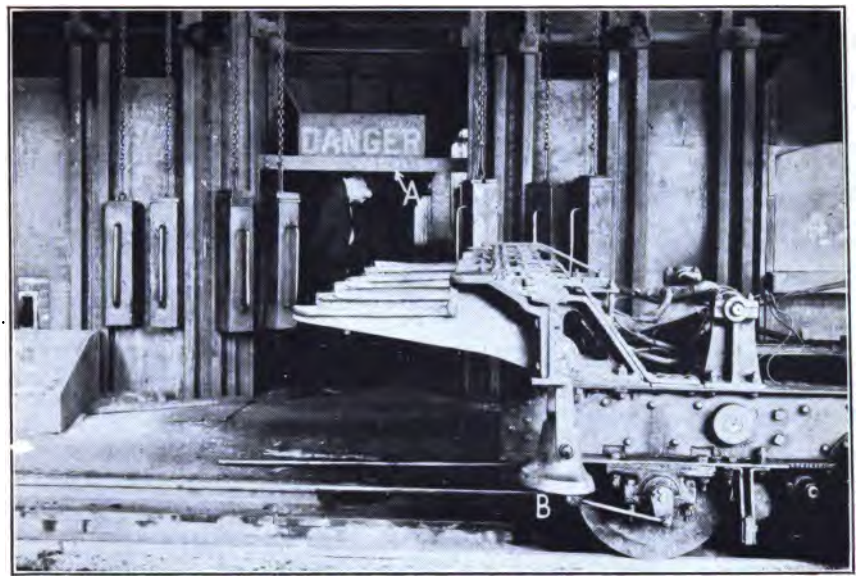

PLATE 51.—BLOOM DELIVERY CAR, WITH DANGER SIGN AND WARNING BELL.

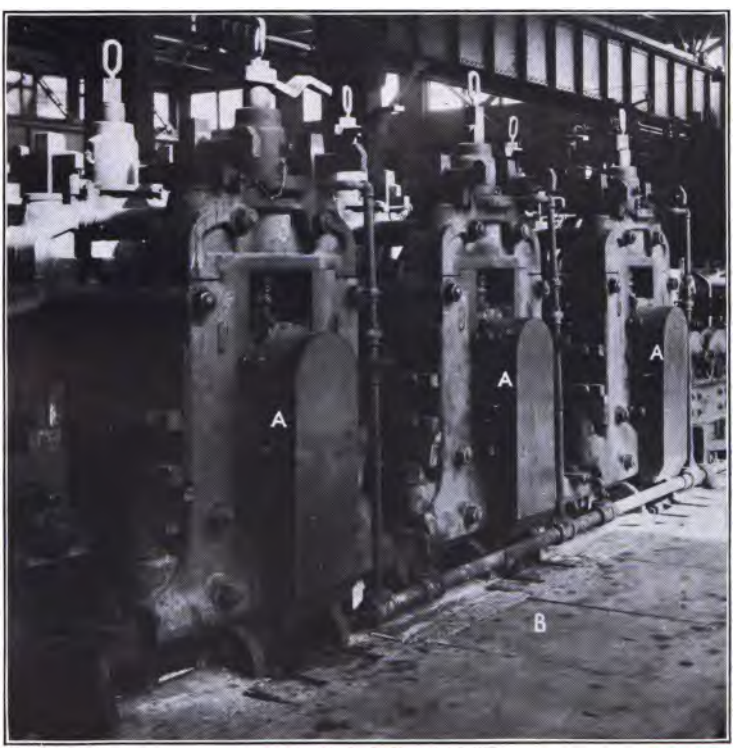

PLATE 52.—SHIELDS OVER ROLL WABBLERS.

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PLATE 53.—TRANSFER TABLE, WITH SHIELD FOR GEARS.

PLATE 54. BRIDGE OVER TRANSFER TABLES.

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PLATE 55.—WALK OVER HOT BED.

PLATE 56.—AUTOMATIC STOP FOR WIRE BLOCK.

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PLATE 57.—EMERY WHEEL, WITH SHIELD AND EYE SCREEN.

PLATE 58.—EMERY WHEEL, WITH SAFETY COLLAR.

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PLATE 59.—CIRCULAR SAW, WITH GUIDE PLATE AND GUARD.

PLATE 60.—WOODEN SHIELD OVER REVOLVING KNIFE.

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SHOPS.

Shops of various kinds, such as carpenter shops, machine shops, etc., are maintained in every large steel plant. Some notable advances in safeguarding have been worked out in this connection. They are not, however, distinctly steel works problems and will not accordingly be so fully treated as has been the case in the characteristic departments.

The grinding of tools is common to all these shops and presents two serious dangers. First, the flying particles of steel and emery thrown off in the process may strike the eye and cause serious damage. A method of safeguarding from this danger is shown in plate 57. A glass plate ("A") is fastened to the hood of the wheel. With a little care it does not interfere with the vision of the workman. In several shops where this device is in use eye injuries in grinding have entirely disappeared. The second danger is from the bursting of the wheel. Some of the grinding wheels are of considerable size and are run at high speed. For the smaller wheels a strong hood ("D") is constructed, inclosing the wheel except at the point where the grinding is done. Owing to the direction in which the pieces tend to fly when the wheel bursts such a hood if sufficiently well constructed is a perfect protection. Also, at "B" is shown a shield about the belt and pulley. For larger wheels is would be difficult to construct a hood of sufficient strength, and such a hood would also interfere with many of the uses to which it is desired to put the wheel. In such cases a special form of wheel with a safety collar (pl. 58) is used. By having a series of collars of different sizes the wheel may be shifted to other uses as it becomes worn down. In the case of the broken emery wheel shown in plate 58 it is altogether probable that one man would have lost his life and others would have been injured had the safety collar not been used.

In the carpenter shops the hazards are chiefly related to unguarded saws of various descriptions and to planers. Many forms of guard have been devised for these machines. Those illustrated have originated in shops connected with steel mills, and so are properly presented here. Plate 59 shows a guard ("G") over a circular saw. At "A" is a sliding guide plate on which, at "F," is a small tongue. This may be forced out by means of the lever "E," so as to catch over the end of the wood being sawed when the latter is too near the saw to handle with the fingers. By this guide plate the wood may be pushed forward without danger.

In plate 60 is shown a sliding wooden shield ("A") over a cylindrical revolving knife. This shield is counterweighted, so that the portion of knife not used is covered automatically. At "B" is a foot lever by which the operator may adjust the shield when the board to be planed is so large as to require the use of both hands. For

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small work the shield may be adjusted by the handle at "C." A brass shoe to reduce friction is shown at "D."

The dangerous machines in shops are lathes, drills, planers, etc. The two illustrations of lathes (pls. 61 and 62), showing the condition in which the machine was received from the makers and the guards afterwards applied, indicate what the dangers are and how they have been lessened. In this connection it is pertinent to note a fact brought out in Chapter II, page 119, where it is shown that in a plant where thorough safeguarding along these lines was undertaken the accident rate in the mechanical department dropped from 388 in 1905 to 114 in 1910. Plate 63 shows a metal planer operated by a moving deck sliding on the bed. The powerful arm above carries the tool and can be adjusted to suit the necessities of the operation. The movements are not very rapid, but when the openings in the bed, closed in the planer illustrated by perforated plates at "A," were uncovered it occurred in a number of instances that a workman reaching into the space for some article was severely bruised or lost an arm. In one case a foreman was standing on the moving platform watching the progress of the work. The tool caught on some harder portion of the piece being machined and the jar was sufficient to cause the man to take a step. His leg went down into the open space and was taken off.

In all shops where power is used the prevalent method of transmission has been by shafts and belts. These present dangers which are provided against by guards extending up sufficiently high to afford security. More serious, however, than direct danger from the belt is that of unexpected starting of the machine. So pronounced is this danger that all laws regarding safeguarding of machinery contain provisions for proper belt shifters. Several new devices in this direction have originated in steel-mill shops.

The really effective method of removing these dangers in a majority of cases is the substitution of direct electrical drive for shaft and belt drive. The perfect and simple control possible by this method and the absence of many moving parts which are otherwise necessary eliminate many dangers.

ELECTRICAL APPLIANCES.

It has already been noted that the use of electrical current for power purposes at once removes a considerable number of dangers and makes comparatively easy the elimination of others. It must not be forgotten that this useful agent also introduces dangers of its own which must be provided against.

The distribution of electrical power with economy involves the use of currents of high potential. The lines carrying such currents and the stations where it is transformed into usable intensities should, as

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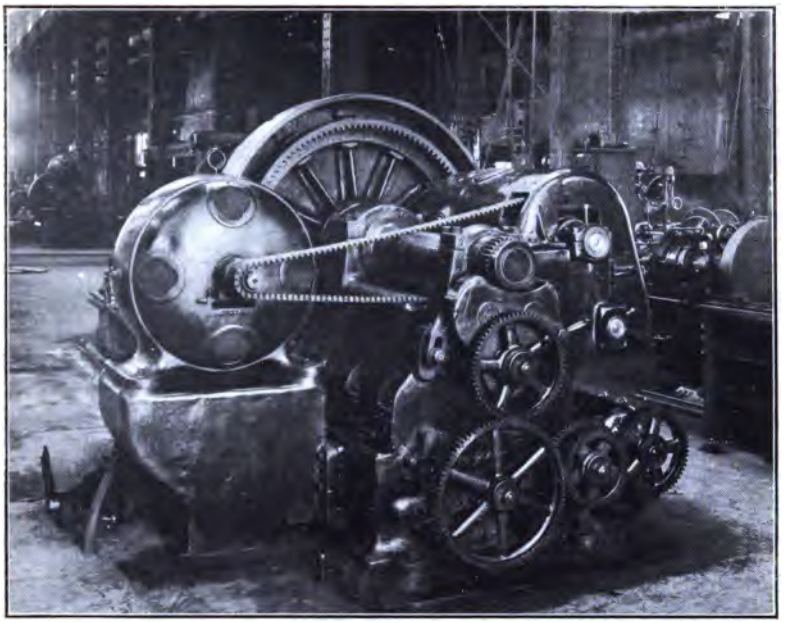

PLATE 61.—LATHE, WITH GEARS EXPOSED.

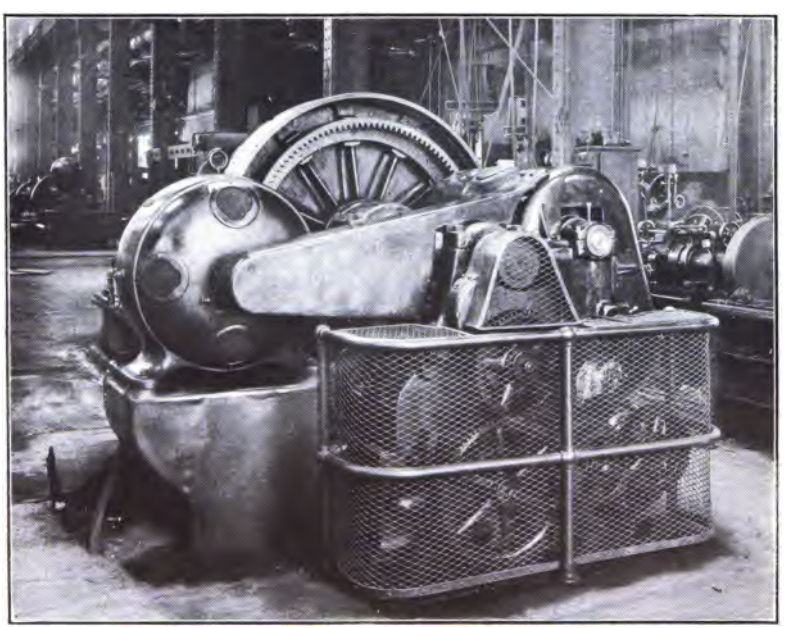

PLATE 62.—LATHE, WITH GEARS COVERED.

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PLATE 63.—METAL PLANER, WITH SAFETY PLATES.

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PLATE 64.—WARNING SIGN FOR HIGH TENSION ELECTRICAL CURRENTS.

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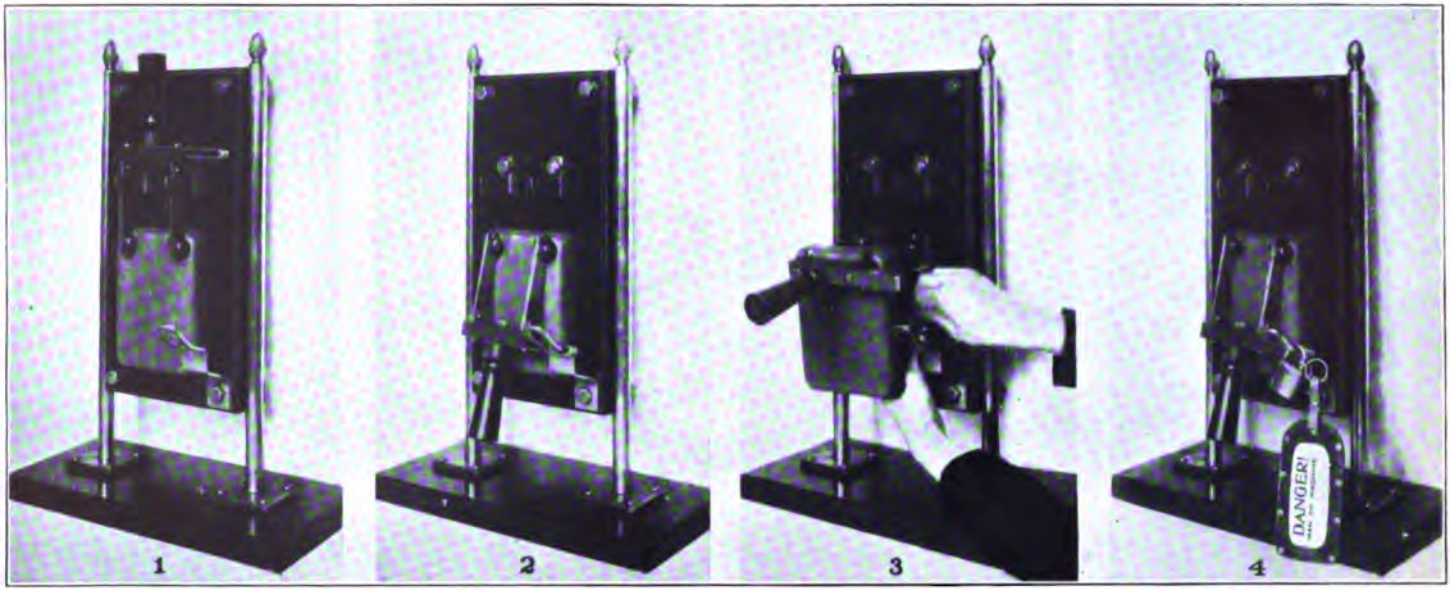

PLATE 65.—ELECTRICAL SWITCH, WITH SAFETY FIBER COVER AND LOCK.

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far as possible, be made inaccessible to those not employed in connection with their management. In addition to this, an easily understood warning sign, like the one illustrated in plate 64, has been used with good effect. The word upon this sign is understood at once by employees of different nationalities, and is therefore particularly suitable in the steel mills.

Some form of switch for turning power on and off is universal where electrical power is used. There are two dangers: (1) A minor danger that a fuse will burn out and that the flash will burn the hand moving the switch, and (2) a very serious danger that the current will be put in action while some workman is in a position to be injured either by the current or by the motion of the machinery resulting from turning it on. The first of these can be removed by placing the fuse at a distance from the switch or by using those of the inclosed type. Both of these methods are frequently inconvenient. The illustration (pl. 65) shows a method of lessening both dangers. The fuses are covered by a fiber box which can be easily shifted when the fuses need renewal, and at other times perfectly protects the hand operating the switch. The second danger is guarded against by the locking arrangement shown. Each workman who may have occasion to work at any point where the closing of the switch would affect him is provided with a padlock. In the plant from which the illustration was drawn a danger tag is attached to each lock. In other plants a chain of some length is attached, making the lock usable for valves, railway switches, and other things of similar character. It will be noticed from the illustration that several locks can be attached to the switch. This makes it possible for several workmen who may be engaged at different points to secure individual safety. Since the lock bears the name of the man to whom it belongs, any neglect in removing the lock upon completing the work is at once traceable to the responsible party. This use of locks as safeguards against the accidents due to unexpected and improper starting of machinery is of very wide application.

OPERATION OF CRANES.

In connection with the discussion of the departments there has been frequent occasion to refer to the use of cranes as a source of danger. This is so pervasive and serious that it is desirable in concluding this chapter to give these devices some further consideration. Four types of crane are used in steel mills: (1) The overhead crane running on tracks supported by the walls of the mills and serving any point on the floor over which they run; (2) the jib crane, useful in lifting and moving objects for a short distance, such as the ladles in the Bessemer; (3) the gantry crane, used in restricted areas of the yards, which is supported by structures moving on tracks at each side of the area carrying a bridge between them; (4) the locomotive crane,

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which can move and act wherever a railway track runs in the yard. The desirable features of construction by which these useful mechanical devices may be rendered safer have been sufficiently discussed.

The operation of cranes calls for some further attention. The chains, hooks, and wire loops so far used are essentially primitive. They serve their purpose and have been allowed to continue without the rigorous revision which has greatly modified other appliances. The hook has been used ever since man first lifted weights from the ground. Scarcely until the safety movement began was a serious attempt made to improve it. The specialized forms of hooks shown in the accompanying plates are all very recent. They indicate what can be done in the direction of improving this simple implement. The first illustration (pl. 66) shows a two-chain sling with special clamp hooks used in carrying plates. In plate 67 is shown a clamp for handling plates in a vertical position. The jaws "A" of this clamp are compound levers pivoted to the movable frame "B" and the fixed yoke "C." The weight of the plate operates to close the jaws and tighten the grip. Plate 68 shows a safety chain hook for pipe mill cranes. The handle "A" enables the operator to manipulate the hook without placing his fingers where they will be crushed between the hook and loop or link into which it engages. This handle is forged from the solid and not brazed on, as the heat necessary for brazing would lessen the strength of the hook. At "B" is a hump which prevents the hook from engaging any object as it rises. In plate 69 is shown a safety hook for the use of buckets, tubs, and other devices for hoisting in a limited space. The latch "C" is operated by the handle "D." When the latch is closed it is impossible for the load to become disengaged and fall.

The study of any plant at the present time will show that the most various methods are in use. The signals are not uniform. A man changed from one gang to another may find that a signal having one meaning to him in the first gang has a different one in the second. Before he learns the difference he may be hurt. Little attention is given to systematic training in this matter of moving materials by cranes. The operation appears so simple that the newest men are often put at work here, with a resulting harvest of accidents.

A system of inspection has already been begun to insure that flaws in the chains or broken strands in the cables do not add to the dangers of what must be at best a hazardous occupation.

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SPECIAL FORMS OF HOOKS USED WITH CRANES.

PLATE 66.—CLAMP HOOKS FOR CARRYING PLATES.

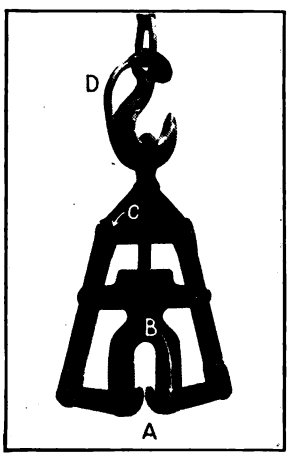

PLATE 67.—CLAMP FOR HANDLING PLATES IN VERTICAL POSITION.

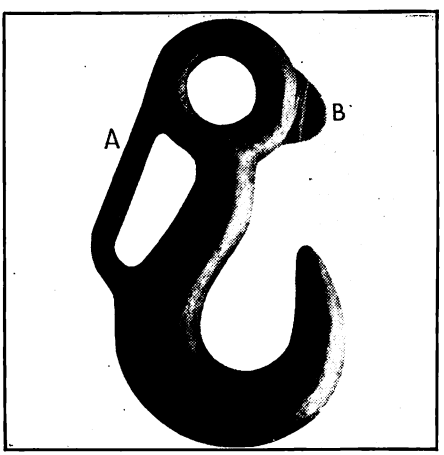

PLATE 68.—HOOK WITH SOLID FORGED HANDLE.

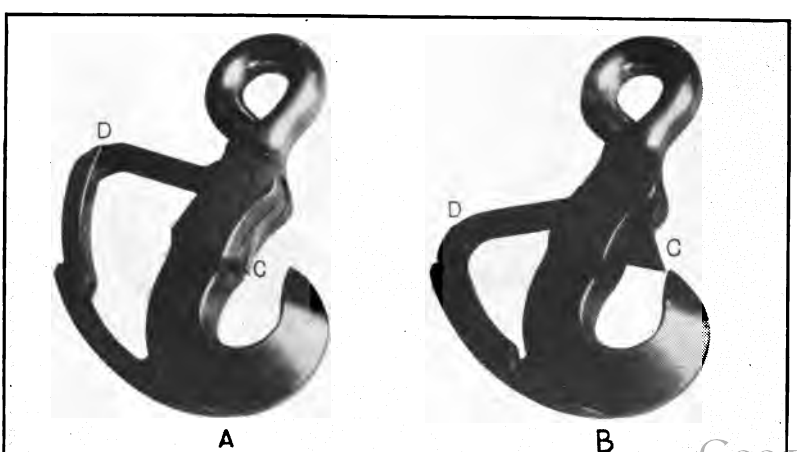

PLATE 69.—SAFETY HOOKS.

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CHAPTER V

ACCIDENT RELIEF AND COMPENSATION SYSTEMS.

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CHAPTER V.

ACCIDENT RELIEF AND COMPENSATION SYSTEMS.

The methods used in industrial plants in dealing with the results of accidents include (1) arrangements for meeting liability through a claims department, (2) caring for the injured through a surgical department and its associated emergency provisions, and (3) dealing with problems of relief and compensation through benefit societies and relief plans.

CLAIMS DEPARTMENT.

Wherever, in the study of plants, a safety organization was found in operation it was discovered to be a more or less direct outgrowth of a claims department. With small plants as a rule this responsibility was usually shifted to an insurance company. A very considerable number of companies, both large and small, still adhere to this plan. It has the serious disadvantage of the intrusion of a third party between the employer and his employees and of widening by a very considerable degree the breach which changing industrial methods had already made between the two classes. Appreciation of this fact and economies in the administration have led the larger organizations to assume the burden of dealing directly with their cases of personal injury. One of the immediate results of this assumption of direct control has been necessarily to bring the company and its workpeople into more immediate contact. This contact, if it were unaccompanied by any other changes, is sure to modify profoundly the relations between the two parties. Whether the modification is for good or evil is dependent upon the character of those coming into contact and the motives with which they approach the problems. It can not be doubted, however, that the more intimate knowledge each of the other growing up under such a system promotes harmony and mutual understanding.

From the outset of its development a claims department has been almost invariably a fighting organization. The laws operative until a very recent period throughout the industrial States dealt with questions arising from industrial accidents on the basis of liability. These laws had come into existence in connection with a simpler condition when owners of industrial enterprises, acting as their own superintendents, were in more direct relations with their men. When, in the process of expansion and differentiation, the

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owner was necessarily removed from this immediate contact his natural tendency would be to protect himself against the demands of an injured workman by every defense available. Equally, on the other hand, would a workman, having no longer any ready means of bringing to the personal attention of his employer his condition and needs, be impelled to press every possible advantage arising out of the real or supposable negligence of the employer. This situation in itself necessarily gave rise to sharp antagonisms. Unfortunately its acrimony was greatly intensified by the opportunity afforded for the intrusion of members of the legal profession, who found in it a means of livelihood. The difficulties besetting the workman in his effort to secure justice were such that abuses were sure to arise. A workman would in very few cases be possessed of resources adequate to meet the costs of prosecuting his claim. This made inevitable, indeed almost necessary, the practice of taking such cases upon a "contingent fee." Both the lawyer and the workman took such great risks in the effort to prosecute the claim that the claim itself was necessarily exaggerated beyond reason, and the proportion of it claimed by the legal representative was very large. So few of these cases could be successfully prosecuted that the only possible method was to secure the largest returns from each good case.

The laws bearing upon this subject are now undergoing a revolutionary change. At least a part of that revolution had its beginning in the experience of men who have operated the claim departments of some of the great industrial organizations. Two ideas had already modified the practice of these departments before the legal changes which are now in progress were initiated. The first of these ideas was that of accident prevention. From this has grown the modern safety organization. The second idea was that the care of the injured man might to advantage be assumed by his employer. From this idea the hospital service and the compensation plans take their rise.

It is not the intention to suggest that these internal motives were the only or even the main springs of action. The purpose in comment upon them is to draw attention to the fact that within industrial organizations conditions were shaping themselves in a way favorable to more enlightened methods with regard to industrial accidents at the same time that the great consuming and controlling public outside was being educated in the direction of wiser and more humane legal provisions.

Casual observation will give the impression that ideas now coming into dominance in the iron and steel industry have arisen very recently and are to be credited to the influence of particular conditions. A close study will disclose a long period of sporadic experi-

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ment and preparation for the present situation on the part of men entirely unknown in the recent active movement. These obscure experimental efforts in accident prevention can not fairly be ignored in undertaking to secure an adequate view of the situation. The present organization and methods of the safety movement had their beginnings far back in a period when to all appearance the industry was in a state of absolute indifference to problems of this kind. That many men saw more or less imperfectly the possibilities of such effort and tried under extremely difficult and discouraging circumstances to realize their ideals, should be clearly recognized.

Two things contributed to make this early work unsuccessful. First, the efforts were so closely associated with the fighting methods of a legal organization that they were supposed necessarily to be a part of it and were regarded with the same antagonism that was engendered in connection with the prosecution and defense of damage suits. In the second place, the motives of the effort were immediately open to suspicion. The prevention of accidents appeared to be undertaken simply because it was less expensive than litigation. Under such circumstances the worker could hardly have any other feeling than that his personal suffering and the distress of his dependents was a matter of heartless indifference. The development of the claims department into anything better than a fighting organization would have been hopeless if it had at all times to be operated by those who looked no farther than simple pecuniary advantage. Fortunately, in a number of these claim departments men of sympathy and breadth of view came into control, and under their guidance the departments began to develop into real safety organizations.

SURGICAL AND EMERGENCY DEPARTMENT.

In nearly every case studied in connection with this investigation the first step toward a modern safety system has been in line of the improvement of the surgical care of the injured. No industry has greater need of the highest skill of the surgeon and medical man than has the iron and steel industry. The facts presented in the preceding chapters show most impressively that the industry is highly hazardous. Many of the dangers to be found in other industries are present, while superadded to them are the peculiar dangers of explosive gas, molten metal, and red hot bars. The present study of the fatalities and the general accidents of the industry shows that these special dangers are a more serious menace to the life and limb of steel workers than are the dangers which the industry has in common with other establishments. The response of the industry to this situation, while rapidly improving, has not always and everywhere been all that the conditions fairly demand.

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Appendix H presents a detailed statement for each establishment reporting in regard to the provisions for the immediate care of the injured and for hospital service. The establishments included in this appendix number 530, a considerably larger number than that covered by the general investigation. For 481 of these the number of employees was reported, and an analysis of these establishments discloses that 160, employing 69,558 men (27.6 per cent of the total employees) provide first-aid appliances. The commonest form of these appliances is the so-called Red Cross box, containing bandages, antiseptics, and other requisites for first-aid treatment. Emergency hospitals or rooms at the plant are found in 110 establishments, employing 134,273 men (53.2 per cent). No provision of this kind exists in 207 plants employing 46,925 men (18.6 per cent). Four plants, employing 1,515 men (0.6 per cent), did not report upon this point. It will be noticed that the larger establishments employing somewhat more than half of the men involved provide emergency hospitals or emergency rooms. Some of the large plants are included among those who rely upon the first-aid appliances. It is the small plants, employing on an average slightly over 200 men each, which have no provision in the way of supplies and appliances at the plant. The operations carried on in these small plants are very often of the least hazardous character, and so the absence of such provisions is less serious, but there are also among them a considerable number of blast furnaces, small isolated plants, whose hazard is not much, if at all, below that of the larger places. The lack of adequate provision in these cases is a serious matter.

The use of the first-aid appliances and rooms above mentioned is accomplished in the 481 plants as follows: 208 plants, with 112,635 employees (44.6 per cent) rely upon a watchman, chemist, or some other employee to care for minor injuries; in 194 plants, with 50,100 men (19.9 per cent), a local physician is called for all injuries sufficiently serious to require attention; 43 plants, with 83,694 men (33.2 per cent), have a surgeon or a trained nurse in constant attendance at the works; and in 36 plants, with 5,842 men (2.3 per cent), the method of attendance was not reported.

The treatment of minor injuries is a matter of considerable importance. It would appear that the introduction of first-aid appliances whose application is in the hands of fellow employees has been a decided improvement over the situation where no such provision was made. It makes possible prompt care in some cases, which if left until the arrival of a local physician might prove very serious. It also assures some treatment of minor injuries which would otherwise very probably receive no attention. The attempt to use this method in a large plant, however, has not been found so successful. In one plant, employing about 8,000 men, for example, these first-aid boxes

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have been very liberally distributed throughout the works. They are in charge of workmen who have other duties occupying them regularly. When called upon for the administration of first aid they must leave their ordinary occupation, which in some cases entails some loss upon them, and they must also do what the circumstances permit toward the degree of cleanliness necessary in applying such provision. A workman under such circumstances is unable to attain "surgical cleanliness." At the time of studying this plant the dangers of this lack of cleanliness had become so evident that special and careful investigation was made in the works and at the hospital. It was found that the proportion of cases of infection becoming serious and so requiring hospital treatment was very high. The hospital had an admirable record in reference to cases serious enough to be sent immediately to the hospital and there properly cared for, but from the emergency cases treated as above described a very great number of infected cases were constantly being received.

Only 11 plants operate their own hospitals. Three of these are reported as serving 16,559 men. These plants were so located that the provision of a special hospital was almost absolutely necessary for satisfactory care. Public hospitals are used by 408 plants, employing 217,135 men. Seventy plants, with 10,179 men, reported that they had no regular hospital arrangements. This does not mean that these plants would not arrange hospital accommodations for injured employees, but are of such small size, and injuries are relatively so infrequent, that it has not been thought necessary to make arrangements except upon the occurrence of an accident.

The accessibility of the hospitals in use by the industry is indicated by the following figures: For 13,357 men the hospital is reported within or at the gate of the works, and may be reached either by stretcher or plant ambulance; 29,961 men are reported distant less than one-half mile, 91,103 one-half mile to 1 mile, 65,953 above 1 mile up to 5 miles, 31,162 above 5 miles up to 10 miles, and 8,393 above 10 miles. The greatest reported distance was 75 miles.

The cost of surgical attention is reported to be paid by the company for 178,677 men (73.6 per cent of those reporting on this subject); by the company in part and the hospital to which the company makes contribution in part for 21,870 men (9 per cent); entirely by an insurance company for 22,690 men (9.3 per cent); entirely by the injured for 19,601 men (8.1 per cent). Complete reports from small plants would considerably increase the number which do not pay hospital charges. Since, however, the number of men (223,237) whose expense for hospital attention is partially or wholly met either directly by the company or indirectly through insurance or hospitals is 91.9 per cent of all reported employees, the omission of the smaller plants can not be greatly significant.

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It is appropriate at this point to discuss one or two incidental features of the hospital administration. First, it has been urged that the hospital is utilized by the claims department to bring improper pressure to bear upon the injured man looking to the settlement of damage claims. In the case of one company, which operates two hospitals for its own men, the chief surgeon, who has been for many years in charge of these hospitals, has from the beginning made it a rule that absolutely no discussion of a possible claim should be permitted while the patient was under his charge. This rule would cover not only the representatives of the company but outside legal advisers. Careful inquiry failed to disclose any cases in which the surgeon's rule on this point had not been rigidly applied. In the case of two other large companies there was some evidence that representatives of the company had at times approached patients before they were discharged, but there did not appear to be evidence that there was effort in these cases to take an unfair advantage. Where public hospitals are in use, inquiries directed to this point did not elicit evidence concerning such improper use except possibly for some cases occurring so long ago that it was entirely impossible to find the interested parties. The conclusion of the investigation must be that the abuse of the hospital along the lines suggested is very rare and in very few cases of serious significance.

The second point is that the public hospitals to which the injured workers are being sent are imperfectly manned and equipped and that they have undertaken to care for the industrial injuries at so low a rate that those suffering from them are neglected. Careful personal inspection and inquiry developed that unsatisfactory attendance and equipment was exceedingly rare. Only one of the hospitals visited treating considerable numbers of industrial accidents could fairly be criticized on either of these grounds. Most of the hospitals in question are established either by municipalities or private benevolence, or in connection with religious organizations, and are, as a rule, admirably managed. The question of neglect resulting from inadequate payment for care is a more difficult one. It seems probable that in some cases of inadequate hospital force there is some justification for complaint in this direction. The responsibility for it must rest upon the establishments which undertake to furnish this care with unreasonable economy.

The material provision in the way of appliances, rooms, and hospitals used by the iron and steel industry has undergone a revolution since 1907. This development is still proceeding with accelerated rapidity and is tending to bring along with it a very widespread and thoroughgoing renovation of general sanitary conditions.

The administration of these means of care lags somewhat. Trained people for their operation are not always readily available. Unfor-

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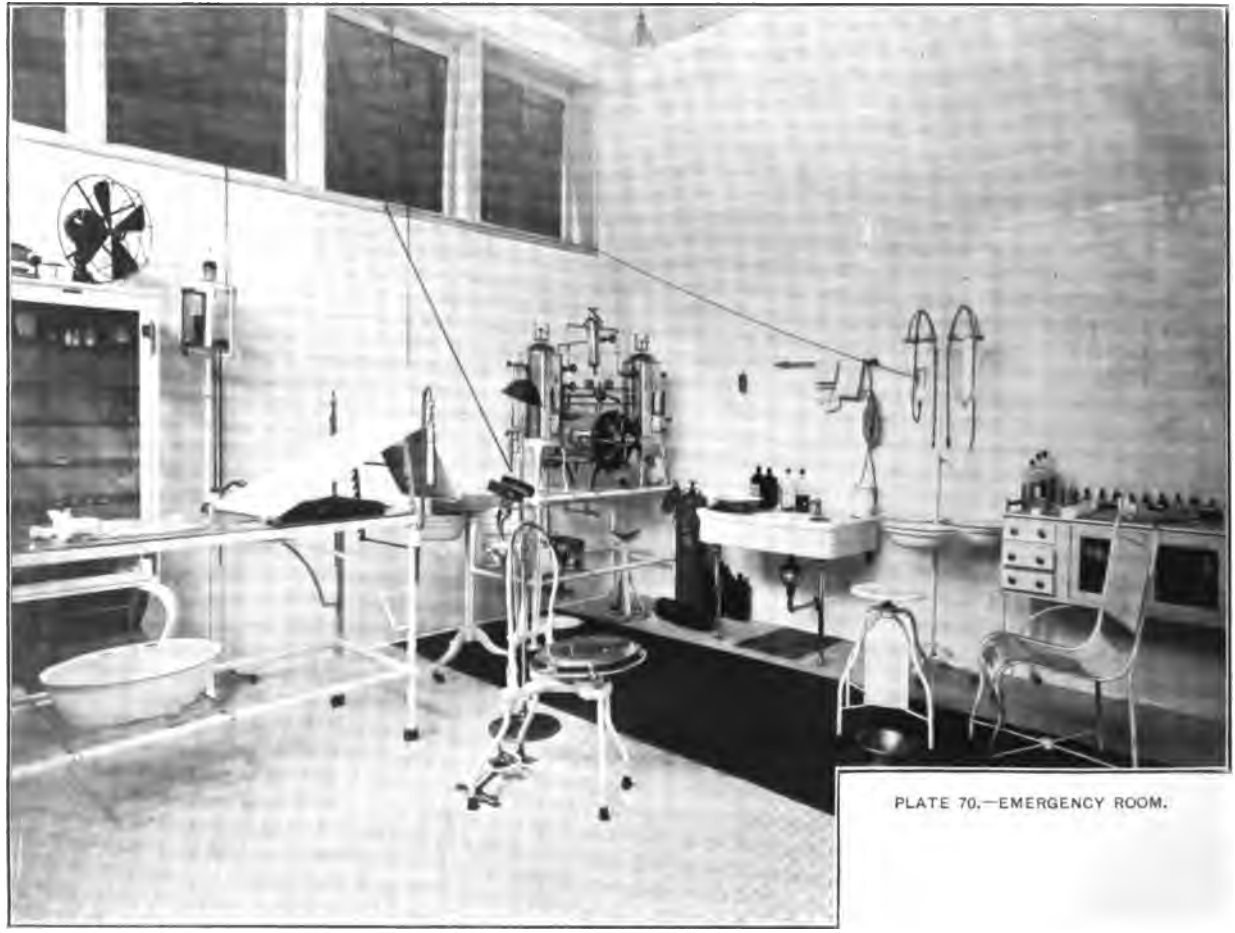

PLATE 70.—EMERGENCY ROOM.

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tunately, also, there is some tendency to take such satisfaction in appliances which look well that the proper application of them fails of due attention. The need for expert administration may be illustrated by the following case: A large company operating a number of plants determined to unify and improve its hospital service. A chief surgeon was employed and given authority to carry out his ideas. He discovered during the first year of his administration that, while previously the disabling accidents giving rise to a day or more of absence from work had been fairly cared for, there was an immense number of nondisabling cases requiring attention as a preventive measure. The majority of these cases had no serious results, but from them had constantly arisen cases of infection involving possible loss of a hand or arm, prolonged illness, or even death. In that first year the emergency treatments were nearly double those of the preceding year. Infection largely disappeared, and a measurable increase in the efficiency of the workers due to this prompt attention was observed.

In the discussion of accidents in a large plant the importance to the manufacturer of adequate care for nondisabling injury is brought out more in detail.[1] Before passing from the discussion of this subject a statement showing what may be attained in the way of provision for immediate care is desirable. The illustration (pl. 70) shows the sort of emergency room which is now available for something like 50 per cent of those engaged in the industry. It is in some particulars more elaborate than has been found necessary for a small plant. It has been found advisable to assign a definite room in every case where the plant employs above 500 men, and to place an attendant in charge whose other duties do not necessarily render him unfit for the giving of aid and who is not made to suffer loss if he takes the necessary time to attend to his injured fellow worker. Where the number of men rises above 1,000, the provision of such a room has been found necessary, with the attendance of trained nurses constantly on duty. In plants of still larger dimensions the best results are attained by the use of a central emergency hospital, with emergency stations distributed at convenient locations throughout the works. While the provision of a plant ambulance or of stretchers makes it possible satisfactorily to handle the more serious cases at the central emergency station, the multitude of minor cases which require immediate but not prolonged attention can not be cared for at a central station without considerable loss. The question of a single central station or such a station with several branches is a local one. The important point is to secure prompt and adequate attention for every bodily injury.

[1] See Chapter II, pp. 116 and 117.

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ACCIDENT RELIEF.

CONTRIBUTIONS BY EMPLOYEES.

Further light is thrown upon the distribution of the cost of various forms of relief in case of accident by the data presented in the accompanying table, showing for 84 establishments from which reports were obtained on the subject their custom with regard to the collection of medical fees. These establishments employed 131,962 workmen. It has been the custom in mining districts to deduct from each payment made to the worker a certain amount for the purpose of providing medical attention in case of need. In iron and steel plants more or less closely connected with mining it has become to a considerable extent the custom to make these deductions. The workman is guaranteed on account of this payment necessary attention in cases of accident, and sometimes of illness, either his own or that of members of his family. The table shows that this practice is not at all common except in the Southern district, where were found over 40 per cent of all the men reported as paying such fees. This is probably due to the fact that many of the southern plants are small isolated plants, usually blast furnaces, and are associated closely with mining operations.

PAYMENT OF MEDICAL FEES IN ESTABLISHMENTS FOR WHICH REPORTS WERE SECURED IN SPECIFIED DISTRICTS.

Districts.	Number of establishments reported.			Number of workmen in establishments reported.		
	In which fees are paid.	In which fees are not paid.	Total.	Paying fees.	Not paying fees.	Total.
Eastern	.....	8	8	.....	18,862	18,862
Pittsburgh	3	30	33	6,701	58,261	64,962
Great Lakes	2	18	20	4,452	33,429	37,881
Southern	14	9	23	7,791	2,466	10,257
Total	19	65	84	18,944	113,018	131,962

The system is one liable to serious abuses. The medical attention may be farmed out to a practitioner who, having other interests and not receiving a very generous return for his work, is neglectful of the patients coming from the iron works. The temptation is also very considerable to make the fee which is retained by the company a source of profit.

LIABILITY INSURANCE.

A second method of providing against the expense incident to industrial accident is that of carrying liability insurance. The smaller plants in the iron and steel industry very generally carry such insurance. The obligations of the liability companies under

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these contracts are so varied that they can not be stated summarily. As a rule they involve the payment of the cost of the first treatment necessary in case of accidents and always include an obligation to defend suits brought against the insured company and the payment of judgments against the company up to the amount of the policy. In a few instances companies carry a policy which calls for stated weekly payments to the injured workman during his period of disability.

BENEFIT ASSOCIATIONS.

A third method of provision is the organization of benefit associations. The following table indicates the extent to which such associations have been used in the portion of the iron and steel industry from which information is available:

PAYMENT OF DUES TO DISABLEMENT AND BENEFICIAL FUNDS IN ESTABLISHMENTS FOR WHICH REPORTS WERE SECURED IN SPECIFIED DISTRICTS.

Districts.	Number of establishments.			Number of workmen.		
	Having payments.	Not having payments.	Total.	Making payments.	Not making payments.	Total.
Eastern	8	.....	8	18,862	.....	18,862
Pittsburgh	8	25	33	25,055	39,907	64,962
Great Lakes	3	17	20	4,223	33,658	37,881
Southern	8	15	23	2,972	7,285	10,257
Total	27	57	84	51,112	80,850	131,962

All the establishments included in the table have some form of association, and it is known that many others not specifically included in this report have similar organizations. In the Southern district the method takes more commonly the form of disablement funds, which are retained out of the wages of the employees by the companies, and are administered by them in the same manner as the funds arising from the medical fees. Where these associations have been most thoroughly developed, they take the form of mutual insurance companies. The workmen who are members of the society pay into its treasury regular dues, and the operating company often makes stated or extraordinary contributions and guarantees the payment of the benefits provided by the constitution.

Since these societies have been of very considerable importance in a number of large companies, it is desirable to present the facts with regard to their organization and operations with considerable detail. In Appendix I the constitution of an association is presented in full. The association under consideration provides weekly benefits in case of sickness and accident, a death benefit to the dependents in certain cases, and to those members who pay a special assessment guarantees a pension after a certain age and certain period of service.

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Nominally membership in this association is voluntary with the employees; but it is so well understood that every employee is expected to join the association that very few fail to do so. The company is, by the constitution, made the treasurer of the association; it supplies office room and necessary clerical service, makes annual contribution to the treasury of "$1 for each member of the association entitled to benefits during the whole year," and guarantees the payment of the benefits provided. In consideration of these items furnished by the company each applicant for membership is required to execute a release to the company "of all action for damages resulting from accident to him while he is a member of this association." The company has the right to cancel its agreement by giving six months' notice, and such cancellation of the agreement dissolves the association. Upon such dissolution the company may apply any money which may remain in the treasury to certain charitable purposes specified in the constitution.

The membership is divided into three classes—a general class who are able to pass a medical examination prescribed by the board of directors; a restricted class, including those who have some physical defect or are above 55 years of age; and a special class who by the payment of an extra fee become entitled to the payment of an extra benefit. The general class is divided on the basis of age into two divisions, those not over 45 years of age and those over 45, the monthly dues of division 1 being 90 cents and of division 2, $1.15. The benefits in the general class are $5 per week for disability resulting from accident or sickness, $100 burial fee in case of death, and a specified amount for the loss of different bodily members, running up to $1,000 in case of total blindness or in case of death by accident. The restricted class has the same weekly benefit as the general class; but the other benefits are one-half those furnished to members of the general class, and their monthly fee is 50 cents instead of 90.

The association operates its own hospital. When members of the association are admitted to the hospital, if they have no persons dependent upon them, the weekly benefits provided for are turned over to the hospital. The constitution provides that a member shall not be entitled to disability or death benefits from accidents due to intoxication or willful negligence on his part. The directors are, however, empowered in cases where a claim for death benefit has been rejected on any of the above grounds to allow a sum not exceeding $100 for funeral expenses. The annual reports of the association indicate that such an allowance is almost invariably made.

The following table presents the changes in membership which have occurred in this association during the period of six years, from 1905 to 1910:

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MEMBERSHIP IN A BENEFICIAL ASSOCIATION FOR 6 YEARS, 1905 TO 1910.

Membership.	1905	1906	1907	1908	1909	1910
Members, January 1	11,631	15,661	16,608	13,578	13,731	16,997
New members	14,023	13,983	11,705	4,169	10,792	13,043
Members reinstated	6,649	6,733	6,689	6,934	8,162	6,135
Total	32,303	36,377	35,002	24,681	32,685	36,175
Members deceased	119	127	165	109	139	156
Members who left employment	16,523	19,642	21,259	10,841	15,549	20,509
Net membership December 31	15,661	16,608	13,578	13,731	16,997	15,510
Accidental deaths in line of duty	40	46	47	22	52	45

It appears from this table that the number of employees necessary to man the establishment from which the membership is drawn averaged 14,701 on January 1 for the six years. In order to maintain this working force it is necessary each year to recruit it by adding new employees or reemploying those who have for a time been out of service to the number of about 18,169 workmen. To state the matter in another way, there is during a normal year a change in the personnel of about 124 per cent. The table also shows that deaths due to accident have been almost uniform throughout the six years, except in 1908, when during the depression they dropped to a low point, and in 1909, when during recovery from the depression they rose much above the ordinary level.

In the following table the receipts and disbursements of the six years are arranged in such form that they may be readily compared.

RECEIPTS AND DISBURSEMENTS IN A BENEFICIAL ASSOCIATION FOR 6 YEARS, 1905 TO 1910.

Items.	1905	1906	1907	1908	1909	1910
RECEIPTS.						
Dues from members	$173,122.00	$197,708.03	$198,546.02	$135,362.33	$180,495.35	$201,538.38
From company	16,933.57	19,118.00	19,438.31	14,228.65	20,834.57	24,084.08
From hospital	3,648.00	3,690.00	4,372.00	2,220.00	1,070.00	1,655.00
Total	193,703.57	220,516.03	222,356.33	151,810.98	202,399.92	227,277.46
DISBURSEMENTS.						
For accidents	119,483.44	141,589.78	147,621.24	86,307.65	141,393.41	149,742.63
For sickness	30,462.12	32,863.43	38,455.68	40,196.70	38,109.91	37,532.02
For hospital and medical expenses	14,056.00	17,264.00	22,202.00	18,085.00	20,588.00	29,074.00
For other expenses	9,408.68	12,175.15	13,219.08	10,932.20	13,344.68	18,286.90
Total	173,410.24	203,892.36	221,498.00	155,521.55	213,436.00	234,635.55
Average benefits per member for accidents	[1] 8.66	[2] 8.93	[3] 9.33	[4] 7.94	[5] 9.59	[6] 9.37

[1] Including 48 cents for burial fees, part of which were for deaths other than from accidents.
[2] Including 45 cents for burial fees, part of which were for deaths other than from accidents.
[3] Including 63 cents for burial fees, part of which were for deaths other than from accidents.
[4] Including 72 cents for burial fees, part of which were for deaths other than from accidents.
[5] Including 52 cents for burial fees, part of which were for deaths other than from accidents.
[6] Including 66 cents for burial fees, part of which were for deaths other than from accidents.

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The gross amount expended for any particular purpose in a given year is not of great significance, since extraordinary conditions in that year may materially influence these items. Except for the depressed year of 1908 the employment has not shown great variation. Since the conditions of payment of benefits have remained unchanged throughout these years and the average number of people employed has not varied greatly, it is possible by comparison of the number of employees with the amounts expended for accident benefits to get a reasonably accurate idea of the trend of accidents. The average payment per member of the association for accident benefits appears in the table as follows: 1905, $8.66; 1906, $8.93; 1907, $9.33; 1908, $7.94; 1909, $9.59; 1910, $9.37. It is evident from these figures that the accident rate which underlies them has not greatly changed in these years. Such change as has occurred has been in the direction of a higher rate.

For purposes of this discussion the following questions may be considered with regard to such an association as this: (1) Is the association operated in an efficient manner? (2) In what respects has the condition of the employees who have come under it been improved as contrasted with the condition prior to the formation of the association? (3) Upon whom does the burden of the maintenance of the association really fall? (4) Are the benefits accruing to the members of the association a reasonable return for the payments which they are making? (5) Does the operation of the association provide indemnity in accord with the best practice? (6) What effect does the existence of such a society have upon the accident problem?

In regard to the first question it may be said that this particular association and many others like it have received the attention of some of the most capable men connected with the companies in which they have been formed, that almost without exception they have been admirably managed, much time and thought having been given gratuitously to their operation, and that from this standpoint they have been efficient.

In every case prior to the formation of such an association the situation under the operation of existing law has been one in which the larger number of those injured received nothing whatever. Some few were awarded considerable sums, but in these cases very large portions of the awards commonly went for legal expenses. These associations have brought it about that practically every workman under their provisions would in case of injury receive some relief, and the expenditure of considerable portions of the relief for legal advice has largely ceased. Inasmuch as these legal contests were the source of great irritation and bitterness between employer and employee, the organization of these associations has been of benefit

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in promoting good feeling. The employing company and the employed men cooperate in the management of the society and so come into relations with each other which make for mutual understanding.

With regard to the incidence of the economic burden, it varies considerably in the different societies. In every case, however, the major fraction of the funds necessary to carry it on is provided by the work people, the company usually furnishing the administrative skill necessary to the success of the organization and contributing to the benefit funds. A somewhat peculiar condition prevails in the particular society under consideration. The section of the constitution providing for the regular payment by the company of a sum "equal to $1 for each member of the association entitled to benefits during the whole year" has already been quoted. Assembling the contributions of the company made under this heading and the further contributions made for clerical and other service, it is found that these contributions ranged from $14,228 in 1908 to $24,084 in 1910. Considering the disbursements, those for hospital and medical attendance ranged from $14,056 in 1905 to $29,074 in 1910. The aggregate expenditures for this item during the 6 years under consideration exceed the contributions of the company for all purposes by $7,626.82. Throughout the iron and steel industry the majority of the companies provide these necessary hospital and medical facilities entirely at their own expense. This company operating a beneficial association has applied to this form of relief both its own contribution and more than $7,000 drawn from the payments made by the men. In view of the fact that the company owns the hospital used by the association and furnishes certain workmen employed about it, it is fair to offset these items against this cost of hospital provision and regard the company as meeting this item of expense. With this allowance the situation is this: The burden of providing accident and sickness benefits falls entirely upon the workmen, with no contribution for this purpose from the company.

Contrasted with the rates charged by ordinary insurance companies for occupations of equal hazard, the average payment per member for accident and sickness is decidedly low, so that it may be said that such a society where, as in this case, the entire payments are derived from the workmen affords them less expensive insurance than they could secure in any other way. It is also the fact that with so fluctuating a body of workpeople it would be quite impossible that they should of their own initiative secure any satisfactory insurance.

Concerning the adequacy of such an association to meet the accident situation, it must be said that it distinctly fails at a critical point between the ideas of the past and the ideas of the present. Down to a very recent period in this country the attempt has been to adjust

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the question of industrial accidents on the basis of fault. If the employer could be shown to be in fault he must bear the burden. Conversely, if the worker were at fault he must bear the burden. The present idea is that of placing the burden upon the industry; that is, accidents are to be regarded in the same light as are breakages of machinery. They must be repaired and the cost of the repair is ultimately transferred to the consumer of the product. It will be noticed that the operation of such a society as has been described above is strictly out of harmony with this idea at one important point. While it improves the condition of the workman very materially, it saddles him with a large part, or with the entire economic burden due to his disability. With the advance of the idea that this burden should be borne by the industry rather than by the man, a very material modification of the methods and aims of such societies will inevitably be necessary.

The final question is much the most important from the standpoint of this report. It has been seen above that, judged both by the number of fatalities occurring from year to year and by the uniformity of the payments made per member on account of the accident benefit, the company in question has not made much progress in the direction of accident prevention. From the facts shown in other parts of this report, it is known that this company has an abnormally high accident rate. Its static condition is not due to the fact that it has progressed so far that little more can be expected. It belongs in the class in which there has been little development of the safety system, described as class C of the three divisions shown in Chapter I, page 45. It is accordingly necessary to inquire what effect the existence of this form of accident relief may have had upon the development of an efficient safety system. At two points the existence of such a society seems very likely to prevent adequate attention to safeguarding. The judgment that this is likely to be the case is reenforced by the fact, discovered in the course of this investigation, that every plant studied in which this form of accident relief was the exclusive form had, unless some other influence had modified conditions, an accident rate higher than was reasonable.

The first influence against scientific accident prevention is exerted upon the company. The results arising from the operation of the association lead inevitably to a condition of satisfaction with regard to accidents and do not tend to remove the feeling of helplessness which has so long characterized the steel industry. It has been noticed that the cost of benefits under the system in operation in this company rests entirely upon the workpeople. This being the case it will not be directly evident to the company that efforts in the direction of safeguarding would be of financial benefit. In the absence of pressure of this kind it is unlikely that efforts toward greater safety will be initiated.

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The second effect of the existence of such a society is upon the working force. Since some provision for the care of the workman when accidents occur has been made, it will be true that the workman, impressed as he is very sure to be with the idea that hazards of this particular kind of work are without remedy, will not be likely to consider ways and means for reducing those hazards. On the whole the situation seems to be a case of "good, the enemy of the best." The association performs a useful function, but in performing that function it has stood squarely in the way, both so far as the company and the workmen are concerned, of a really thoroughgoing effort to meet and master the accident problem.

It is desirable in this connection to present a comparison which will show clearly what might have been accomplished by accompanying a remedial effort by an equally vigorous one directed toward the source of the difficulty. It has been shown that employment in the plant under consideration was nearly uniform from 1905 to 1910, except for the year 1908. The number of deaths and the average payments per member both indicate a nearly stable condition. In the absence of precise figures regarding accidents other than fatalities the average benefit payments per member are assumed to represent the trend of accident rates, and relative figures showing this trend have been computed from these averages, using 1905 as 100. Relative rates based on the accident rates in a plant with a well-developed safety system are brought into comparison with these figures in the table which follows. The last column of the table shows the percentage of loss from accidents possible to avoid by reducing the rates in the plant under consideration to those in the plant with good safety conditions.

PER CENT OF LOSS FROM ACCIDENTS POSSIBLE TO SAVE BY REDUCING THE ACCIDENT RATES FOR THE PLANT UNDER CONSIDERATION TO THE RATES FOR A PLANT HAVING A GOOD SAFETY ORGANIZATION, 1905 TO 1910.

[In the absence of data for computing actual accident rates for Plant I it is assumed that the trend of accident rates follows that of the average benefits paid and that the relative accident rate is expressed approximately by the relative amount of benefits shown in the third column.]

Years.	Average benefits per member for accidents in Plant I (the plant whose benefit society is under discussion).		Accident rates per 1,000 300-day workers in Plant II (a plant with good safety organization).		Per cent of accident loss apparently possible to save in Plant I, assuming that the relative benefits represent approximately the relative accident rates and could be reduced to the relative rates shown for Plant II.
	Actual amount.	Relative amount (1905=100).	Actual rate.	Relative rate (1905=100).	
1905	$8.66	100	300	100	.....
1906	8.93	103	214	71	31
1907	9.38	108	189	63	42
1908	7.94	92	150	50	46
1909	9.59	111	174	58	48
1910	9.37	108	133	44	59

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The table shows that by an effort toward safety as successful as that shown in Plant II from 31 to 59 per cent of the accidents which occurred in Plant I might have been eliminated in the years from 1906 to 1910. What this would have meant to the company is indicated approximately in the following table. For instance, the association expended in 1910 for accident benefits, as shown in the table on page 249, $149,742.63. Had the accidents been 59 per cent less the saving in benefits would have been in round numbers, $88,300. It is assumed that for those injured in this company the weekly wage is not less than $12.50 per week. Since the weekly benefit payment is $5 the loss in wages would be $2.50 for each dollar of benefit payment. Multiplying the amount possible to save in benefits ($88,300) by $2.50 gives $220,750 as the possible loss in wages to those injured in 1910. The company would have saved in the necessary hospital expense, which, as has been noted, is the item which their various contributions to the association cover. In 1910 their expenditure for these purposes was $29,074, and a possible saving of 59 per cent would have amounted to about $17,200. These sums saved by the company would have gone far toward meeting the expense entailed by safeguarding effort.

AMOUNT OF POSSIBLE SAVING BY ACCIDENT PREVENTION TO WORKPEOPLE AND TO COMPANY, FOR PLANT UNDER CONSIDERATION, 1906 TO 1910.

[In this table the savings in benefit payments and in hospital charges are found by applying the possible percentage of saving shown in the second column to the disbursements for accidents and for hospital charges shown in the table on page 249.]

Years.	Per cent possible to save.	Amount possible to save to workpeople in benefit payments.	Amount possible to save to company in hospital charges.	Total amount possible to save by accident prevention.
1906	31	$43,900	$5,400	$49,300
1907	42	62,000	9,300	71,300
1908	46	39,700	8,300	48,000
1909	48	67,900	9,900	77,800
1910	59	88,300	17,200	105,500
Total		301,800	50,100	351,900

The above table shows that, had the rates charged in the association remained the same, the sum saved in accident benefits would have been enough to have furnished a fund which could have been applied to safeguarding purposes, amounting to about $301,800. In addition to this the lessened hospital charges would have brought the sum available for accident prevention up to $351,900. The latter amount is as liberal as that expended even by those companies that have undertaken safeguarding effort on the most generous scale.

There is another element in this situation which it is not possible exactly to estimate. Not only would the company and the work-

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people have gained as shown above, but there would necessarily be a very important increase in the efficiency of labor. An accident not only causes loss by its immediate effects, but the worker rarely returns to his task in quite the condition which he had before the accident. He may appear to have entirely recovered, but his efficiency is often somewhat reduced. The frequent occurrence of accidents has a depressing effect upon the entire body of workers. On the other hand the consciousness that efforts are constantly being made for their protection tends in the direction of cheerful and efficient service. There is reason to believe that these effects upon efficiency which can not be estimated in terms of dollars and cents are after all quite as important as those that can be so estimated.

The organization of beneficial associations is plainly not the complete solution of the accident problem.

COMPENSATION SYSTEMS.

The fundamental idea of compensation as distinguished from the old idea of liability is that the burden of industrial accident should be carried by the industry. This really means, when carried to its conclusion, that the burden rests upon society, which is calling for and using products, rather than upon either the employer of labor or the workmen. The incidence of this new mode of treating accident is apparently upon the employer, and if it were true that he must both in the beginning and ultimately bear the entire burden, he might be justified in feeling that it was both a serious handicap and an injustice. Since this form of treatment is of very recent application in this country, although well understood and of almost universal application in Europe, it is desirable to present with careful attention to detail the plans which have been worked out and put into operation.

Since May, 1910, approximately 140,000 of the employees in the iron and steel industry, as considered in this report, have been under the operation of such a system. The companies which have it in operation differ slightly in details but the essential principle is the same in all cases. The statement of organization which follows is that in force in the International Harvester Co., a subsidiary of which, the Wisconsin Steel Co. is included in the report. This company also maintains a separate organization for the provision of sickness benefits and old-age pensions.

ACCIDENT RELIEF PLAN.

1. MEMBERSHIP.

Employees of the above named companies, who are employed in the works, twine mills, lumber mills, steel mills, mines, and on the railroads, are entitled to the benefits of this plan.

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2. PURPOSE OF PLAN.

The purpose of this plan is to insure to employees at the works, twine, steel and lumber mills, mines, and on the railroads, prompt, definite and adequate compensation for injuries resulting from accidents occurring to them while engaged in the performance of their duties; and also to provide compensation to the widow, children and relatives, who may be dependent upon any employee whose death results from such accident.

The benefits provided for by this plan will be paid regardless of legal liability on the part of the company, and no injured employee will require legal assistance to collect the money to which he is entitled. All necessary blanks and information will be furnished, and settlements will be made as far as possible directly with the person entitled to receive the benefits.

The company will make an earnest effort to see that every dollar which becomes due under this plan is promptly paid, and to save its employees from the delays and expenses of litigation.

3. AMOUNT OF COMPENSATION.

The company, without any contribution from the employees, under this plan will pay:

In case of death: Three years' average wages, but not less than $1,500 nor more than $4,000.

In case of loss of hand, foot, or eye: Special benefits as hereinafter stated.

In case of other injuries: One-fourth wages during the first 30 days of disability; if disability continues beyond 30 days, one-half wages during the continuance thereof, but not for more than 104 weeks from the date of the accident. Thereafter, if total disability continues, a pension will be paid.

4. CONTRIBUTION BY EMPLOYEES.

The one-fourth wages paid by the company during the first 30 days of disability, will be increased to half-wages in favor of employees who make the following contributions:

Employees earning $50 a month, or less, 6 cents per month; more than $50 and not more than $100, 8 cents per month; more than $100, 10 cents per month.

It is estimated that these contributions, together with the one-fourth wages paid by the company, will be sufficient to provide half-pay for all injured employees during the first 30 days of disability. If experience shows that the employees' contributions are more than sufficient for this purpose, then the employees' contributions will be reduced accordingly.

5. PAYMENT OF CONTRIBUTIONS.

Deductions to cover the employees' contributions for benefits during the first 30 days of disability under this plan, will (unless the employee gives to the works superintendent or board of management written notice to the contrary) be made from the employees' wages on regular pay days on the following basis: Employees earning $50 or less per month, 6 cents per month; earning more than $50 and not more than $100 per month, 8 cents per month; earning more than $100 per month, 10 cents per month.

6. COOPERATION WITH COMPANY.

The company earnestly desires the cooperation of its employees in the payment of benefits for the first 30 days of disability, because it wishes every employee to assist in the prevention of accidents. The company has expended large sums in safeguarding machinery and in the effort to protect its employees from injury, but without the active cooperation of the employees many accidents can not be avoided. Under this plan the company and the employees equally divide the payment of benefits during the first 30 days of disability, and thus every employee becomes financially interested in guarding against accidents and in seeing that his fellow workmen are equally careful. It is hoped that this mutual interest will lead to active cooperation on the part of the employees and that thereby accidents will be reduced to a minimum.

7. MANAGEMENT.

This department will be managed by a board of management composed of five members appointed by the associated companies.

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All employees necessary to conduct this department shall be appointed by the board. The board may arrange to have the benefits paid and the necessary medical examinations made through the organization of the Employees' Benefit Association. Should this be done, the Employees' Benefit Association will be reimbursed for all expenses incident to the work of this department.

8. OPERATING EXPENSE.

All expenses of this department shall be paid by the companies associated in the administration thereof. No part of the contributions from employees shall be used to pay expenses, but such contributions shall be used solely to pay one-half of the disability benefits for the first 30 days.

9. ANNUAL REPORT.

The fiscal year of the department shall be the calendar year. A detailed report, including all receipts and disbursements, shall be printed annually, and employees may procure copies thereof on application.

10. MEDICAL EXAMINERS.

The medical examiners shall be appointed by the board of management. In every case of injury they shall make an examination of the injured employee; shall decide when an employee is disabled, and when able to work; and shall perform such other duties as shall be required of them by the board of management.

No bills for medical or surgical treatment shall be paid by the company unless the medical examiner or the works physician finds it necessary to provide additional or different medical or surgical treatment, or to remove the patient to a hospital in order to aid prompt recovery.

11. DISABILITY BENEFITS.

Benefits under this plan will be paid for personal injuries to employees caused by accidents arising out of and in the course of their employment at the works, twine, lumber and steel mills, mines, and on the railroads.

(a) For each working day, or part thereof, during the continuance of disability:

During the first 30 days of disability one-quarter of the employee's average daily pay, and an equal amount paid out of the fund contributed by the employees, if the injured employee is a contributor to such fund;

After the first 30 days, half-pay during the continuance of disability, but not for more than 104 weeks from the date of the accident.

These disability benefits shall be payable every two weeks, and, in no case, shall exceed $20 a week.

(b) An employee who has received disability benefits under this plan for the period of 104 weeks, and who is then totally disabled, shall, so long as his total disability continues, be paid an annual pension equal to 8 per cent of the death benefit which would have been payable had the accident resulted in death. Such pension shall not be less than $10 per month, and shall be payable monthly.

(c) Disability benefits shall be based upon the average daily wages received during the 60 days worked preceding the accident. If the injured employee has not been in the company's employ for 60 days prior to the accident, then upon the average daily wages received during the period he has worked.

(d) No disability benefits shall be paid unless written claim therefor be made to the board of management within 30 days after the date of the accident.

12. SPECIAL BENEFITS.

Loss of feet and hands.

(a) If the injury causes the immediate severing of, or (in the opinion of the medical examiner or works physician) necessitates the amputation of a hand or foot at or above the wrist or ankle:

One and one-half years' average wages, but in no event less than $500 nor more than $2,000;

(b) In case of the loss of both hands or both feet, or one hand and one foot, as aforesaid:

Four years' average wages, but not less than $2,000.

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Eyes.

(a) In case of the total and irrecoverable loss of the sight of one eye: Three-fourths' of the average yearly wages;
(b) In case of the total and irrecoverable loss of the sight of both eyes: Four years' average wages, but not less than $2,000.

Payment of special benefits.

An employee receiving special benefits shall not be entitled to any other benefits except as hereinafter stated:

If an employee entitled to special benefits dies before the payment thereof, no special benefits shall be paid, but his dependent relatives shall be entitled to death benefits as hereinafter provided. If an employee who has received special benefits dies as the result of the injury within 12 months from the date thereof, then death benefits shall be paid, but there shall be deducted from such death benefits all sums theretofore paid as special benefits.

No special benefits shall be paid on the basis of annual wages exceeding $2,000; nor unless the loss of foot, hand, or eye shall occur within 12 months after the date of the injury and shall be the direct result of the injury, nor unless written claim therefor be made to the board of management within 30 days after the loss of the hand, foot or eye.

13. LUMP-SUM SETTLEMENTS.

In case of serious injury, where the employee desires to accept a lump sum in lieu of weekly disability benefits and pension, the board of management has authority to make full and final settlement with such employee on such terms as may be agreed upon in writing.

14. DEATH BENEFITS.

The amount of compensation for death resulting from accidental injury arising out of and in the course of employment shall be:

If the employee leaves a widow, child or children, or other relatives, dependent upon his earnings for their support, benefits shall be paid as follows:

(a) If death results from such accident before the expiration of 16 weeks from the date thereof:

Three years' average wages (but not less than $1,500 nor more than $4,000).

(b) If death results from such accident between the end of the sixteenth week and the end of the fifty-second week after the date thereof:

Two years' average wages (but not more than $3,000), less all disability benefits paid.

If the employee leave no widow, children or other relatives, dependent upon him for their support, then reasonable hospital and medical expenses, and a further sum for burial expenses not less than $75 nor more than $100.

All death benefits shall be paid to the administrator or executor of the deceased employee, in trust for his widow, children, or relatives, who were dependent.

No death benefits shall be paid unless death result within 52 weeks from the date of the accident, nor unless a written claim therefor shall be filed by the executor or administrator of the deceased employee with the board of management within 3 months after the employee's death.

15. AVERAGE YEARLY WAGES.

"Average yearly wages" as used herein with reference to special and death benefits shall be computed as follows:

The employee's average daily wages during the year of his employment preceding the date of the accident shall be multiplied by the number of working days in that year. If the injured employee has not been employed for a whole year, then the average yearly wages shall be computed by multiplying such employee's average daily wages, during the time he has been employed, by the number of working days in the year preceding the date of the accident.

16. NOTICE OF ACCIDENT.

To entitle an injured employee to benefits, he must immediately give notice, or cause notice to be given, to his timekeeper, of the time and place of the accident, the nature and cause of the injury, and of his residence address, and must submit immediately to a physical examination by the medical examiner or works physician, or other physician designated by the company, and strictly follow the directions given by such medical examiner or physician.

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The payment of benefits shall cease if the injured employee refuses to follow the directions of the medical examiner, works physician, or physician designated by the company, and shall cease when the medical examiner or works physician reports an employee who has been injured as able to work.

17. DISABILITY DEFINED.

The word "disability," whenever used in this plan, means inability to work at any gainful occupation whatsoever, whether of the kind the employee was engaged in at the time of the injury, or not.

No benefits shall be paid unless the injury or death is caused, directly and solely, by an accident arising out of and in the course of the employment. Benefits shall not be paid for any injury or death caused by accident unless there shall be external and visible marks upon the body of physical injuries, which, in case of death, must have been sufficient to have caused such death. Benefits shall not be paid for any injury or death resulting from or caused, directly or indirectly, wholly or in part, by the intoxication or partial intoxication of the employee, or by his failure to use the safety appliances provided by the company, or by his gross or willful misconduct.

No benefits shall be paid for injuries resulting from accidents due to causes beyond the control of the employer, such as riots, conflagrations, lightning, cyclones, hurricanes, storms, floods, earthquakes, or any acts of God.

18. MEANING OF WORD "COMPANY."

The word "company" whenever used in this plan, shall mean the company for which the employee is working when injured.

19. ADJUSTMENT OF CLAIMS.

The decision of the medical examiner or works physician as to the existence and duration of disability shall, subject to the approval of the board of management, be binding upon all employees. The decision of the board shall be final in regard to all questions arising in connection with the administration of the department and the payment of benefits; provided, however, that any employee dissatisfied with the decision of the board of management, may take an appeal, in writing, to the trustees of the Employees' Benefit Association. Such appeal shall be taken in the same manner, and upon the same notice, as is required by the rules of the benefit association in the case of appeals from the decision of the superintendent of said association to the trustees thereof.

20. ACCEPTANCE OF BENEFITS.

The acceptance of any of the benefits herein provided shall operate as a release and satisfaction of all claims against the company, and all other companies associated in this department, arising out of the injury or death for which such benefits are paid. All persons accepting benefits shall give a written receipt evidencing such release. No death benefits shall be due or payable unless such a release shall have been duly executed by all persons who might legally assert any claim growing out of the death of the employee. The commencing of any legal action whatsoever against any of the companies associated in this department on account of such injury, by the employee, or in the event of his death, by his executor, administrator, or personal representatives, shall be a bar to the recovery of any and all benefits herein provided; but in such event the employee shall be entitled to have refunded to him any contributions paid since the receipt by him of disability benefits, and no more.

The benefits of this plan are offered upon the express condition that all the rules and regulations herein contained shall be faithfully and strictly obeyed by the employees, and a complete compliance with each and all such rules and regulations shall be and is a condition precedent to the right to receive any benefits whatsoever.

21. AMENDMENT OF PLAN.

The company reserves the right to change, alter or modify these regulations at any time. Notices of all changes shall be posted at the works, mills, mines and railroad stations at least 30 days prior to the date the same become effective. Such changes shall not apply to cases of injury occurring prior to the date when the change becomes effective.

NOTE.—If the person entitled to receive death benefits so desires, the company will pay the amount of death benefits in monthly installments of not less than $20 each, and allow 4 per cent interest upon all unpaid balances.

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Some points in the foregoing constitution should receive special comment. Immediately upon entering the service of the company the employee, without the necessity of any action on his own part, becomes entitled to the benefits of the plan. In case of injury the plan is so adjusted that automatically the case is brought under consideration and the benefits provided are available for the injured workman and his dependents. One feature in which this plan differs from some others which are in operation is that the payments during the first 30 days of disability are on a lower scale, but begin with the date of the accident. By means of a very small contribution the employee can increase the possible benefits during the first 30 days of disability from one-fourth to one-half his ordinary wages. The period during which benefits will be paid is 104 weeks, a period twice as long as that provided in a number of similar plans. It is provided that the contributions and the benefit funds received from the workmen shall not in any case be applied to the ordinary expenses of the organization, but shall be applied entirely to increasing the benefits. The costs of all necessary medical and surgical treatment are borne by the company. If disability continues beyond the period of 104 weeks the injured employee is transferred to the pension department and receives thereafter, so long as disability continues, a pension of not less than $10 per month. For loss of a hand or foot not less than $500 nor more than $2,000 is paid; of both hands or both feet, or one hand and one foot, not less than $2,000; for complete blindness not less than $2,000. The death benefits provided range from a minimum of $1,500 to a maximum of $4,000. While the constitution contains a requirement that the injured employee shall give notice of his injury in order to be eligible to benefit, in practice the system of administration followed renders such notice in most cases unnecessary. Under the normal and orderly operation of the plan the injured workman will receive his appropriate benefits with a minimum of responsibility and attention on his own part. The acceptance of the benefits provided for in the plan operates as a release for all claims against the company.

The advantages of such a plan as this have been brought out incidentally in the preceding discussion. They may be summarized as follows: First, it removes from consideration the very difficult question of responsibility. So many and such obscure factors enter into the question of the relative responsibility of employer and employee that it is entirely impossible to be sure, even under the most searching judicial inquiry, that they have been correctly determined. This difficulty of determination brings it about that in almost every case where an attempt is made to settle the question upon that basis the most bitter antagonisms are generated between the parties. The elimination to a large degree of such antagonisms is one of the first

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and most important fruits of such a relief plan. Second, prompt and adequate relief is provided in each case. Under the old plan relief was never prompt and was never equitably distributed. A few claimants succeeded in obtaining large sums; the great majority obtained nothing at all. Third, the necessary effect of such a system, both upon employer and employee, is to direct adequate attention to the subject of accident prevention. The employer, who now has a definite financial responsibility toward each accident, will desire on this account to reduce them to a minimum. He is in a position to initiate and procure intelligent and effective measures in this direction, as appears in the discussions of Chapters I and II. The workman, on the other hand, is relieved of anxiety with regard to the situation of his family in case he suffers an injury, and very soon, if it is particularly brought to his attention, realizes that an accident prevented not only saves him the personal suffering incident to such occurrences, but also benefits him in the larger financial return incident to steady ability to earn his wages. Nothing has been more noticeable in the course of this investigation than the remarkable response made by the working people to safety effort. It is not too much to say that the important reductions in accident rates which have been achieved wherever the effort has been vigorously prosecuted are due very largely to this cooperation on the part of the workers. It is extremely doubtful whether such cooperation can by any possibility be attained without the adoption of the compensation system. Repeated instances have been observed in the course of the investigation where every other method of promoting safety seemed to be in a vigorous operation, but in nearly all these cases the accident rates showed that the results were less satisfactory than in similar establishments having compensation. Both theoretically and practically the system appears to be a necessary element in successful safety work.

The largest system of this kind in operation in the country is that of the United States Steel Corporation. It is, of course, impossible to determine in the brief time during which it has been in operation the degree to which it is adapted to the situation. Some figures are available for the operation of this plan for the first 11 months of its existence. This period ended March 1, 1911. The data are those pertaining to the manufacturing operations of the company, and do not include mining, transportation, etc. The number of men affected during this period in the manufacturing plants was 132,561. The total cost of the plan during that period was $1,227,237.99. This outlay was distributed among the different items of expense as follows: Temporary disabilities, 12 per cent; permanent disabilities, 22 per cent; death benefits, 25 per cent; or a total of 59 per cent going directly to the injured workmen for benefits. The collateral

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expenses for emergency attention and hospitals were 24 per cent. The operating expenses of the safety departments, inspection, and other similar items were 17 per cent. This last item does not include expenditures in the way of safety devices or other measures tending to safeguard the worker. The annual cost per man employed of the operation of this plan was, on the basis of the 11 months in question, $10.10. When it is remembered that for occupations of the degree of hazard found in the steel mills the rate of accident insurance companies for a policy giving $1,000 in case of death and $5 per week during disability is at least $12.50 per year it will be seen that this expenditure is reasonable. Both the rate of weekly allowance and the average death benefit are known to be considerably higher than that called for by the policy mentioned above. Since disabilities arising from accident may give rise to need for some form of pension, it is proper in this connection, without discussing details, to call attention to the fact that such provision exists, and is available for at least 150,000 men in the iron and steel industry.

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APPENDIXES.

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APPENDIX A.—NUMBER OF POSITIONS, 300-DAY WORKERS, AND ACCIDENTS RESULTING IN FATAL, PERMANENT, AND TEMPORARY INJURIES IN EACH OF 155 PLANTS, BY DEPARTMENTS, YEAR ENDING JUNE 30, 1910.

Plants and departments.	Positions.	300-day workers.	Accidents.			
			Fatal.	Permanent injury.	Temporary disability 1 day and over.	Total.
Plant No. 1:						
Puddling	42	35	.....	.....	.....	.....
Rolling (hand)	143	108	.....	1	13	14
Mechanical	22	15	.....	.....	1	1
Total	207	158	.....	1	14	15
Plant No. 2:						
Rolling (hand)	117	88	.....	.....	7	7
Yards	25	19	.....	.....	3	3
Other	47	35	.....	.....	.....	.....
Total	189	142	.....	.....	10	10
Plant No. 3:						
Steel foundry	2,447	2,348	.....	1	46	47
Plant No. 4:						
Blast furnace	360	438	.....	.....	27	27
Plant No. 5:						
Blast furnace	64	61	.....	3	.....	3
Open hearth	82	59	1	1	7	9
Rolling (mechanical)	62	38	.....	.....	1	1
Yards	294	222	2	.....	16	18
Mechanical	111	84	1	.....	5	6
Other	23	17	.....	.....	2	2
Total	636	481	4	4	31	39
Plant No. 6:						
Blast furnace	116	141	.....	.....	17	17
Plant No. 7:						
Rolling (hand)	114	98	.....	.....	27	27
Other	93	100	.....	.....	30	30
Total	207	198	.....	.....	57	57
Plant No. 8:						
Rolling (hand)	100	90	.....	.....	9	9
Plant No. 9:						
Open hearth	59	61	.....	.....	5	5
Yards	42	43	1	.....	8	9
Mechanical	83	85	.....	.....	7	7
Steel foundry	904	931	.....	8	87	95
Other	15	15	.....	1	13	14
Total	1,103	1,135	1	9	120	130
Plant No. 10:						
Rolling (hand)	116	93	.....	.....	2	2
Yards	109	86	.....	.....	4	4
Mechanical	57	45	.....	.....	1	1
Other	173	134	.....	1	17	18
Total	455	358	.....	1	24	25
Plant No. 11:						
Steel foundry	187	123	.....	.....	14	14

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APPENDIX A.—NUMBER OF POSITIONS, 300-DAY WORKERS, AND ACCIDENTS RESULTING IN FATAL, PERMANENT, AND TEMPORARY INJURIES IN EACH OF 155 PLANTS, BY DEPARTMENTS, YEAR ENDING JUNE 30, 1910—Continued.

Plants and departments.	Positions.	300-day workers.	Accidents.			
			Fatal.	Permanent injury.	Temporary disability 1 day and over.	Total.
Plant No. 12:						
Open hearth	116	120	.....	3	32	35
Rolling (mechanical)	160	113	.....	1	26	27
Rolling (hand)	40	29	.....	.....	21	21
Other	179	139	1	5	128	134
Total	495	401	1	9	207	217
Plant No. 13:						
Steel foundry	269	245	.....	.....	31	31
Plant No. 14:						
Steel foundry	739	725	.....	2	17	19
Plant No. 15:						
Puddling	52	29	.....	.....	3	3
Plant No. 16:						
Open hearth	159	118	2	2	18	22
Yards	39	32	.....	.....	17	17
Mechanical	82	67	.....	.....	9	9
Other	771	641	2	1	95	98
Total	1,051	858	4	3	139	146
Plant No. 17:						
Open hearth	280	290	1	.....	37	38
Rolling (mechanical)	188	60	.....	.....	32	32
Yards	164	137	.....	1	23	24
Mechanical	31	26	.....	.....	7	7
Other	129	83	.....	3	5	8
Total	792	596	1	4	104	109
Plant No. 18:						
Steel foundry	438	453	1	2	62	65
Other	241	212	.....	1	22	23
Total	679	665	1	3	84	88
Plant No. 19:						
Steel foundry	313	340	.....	.....	16	16
Other	125	65	.....	1	3	4
Total	438	405	.....	1	19	20
Plant No. 20:						
Yards	200	151	.....	.....	2	2
Mechanical	600	454	.....	.....	5	5
Steel foundry	837	633	1	.....	69	70
Total	1,637	1,238	1	.....	76	77
Plant No. 21:						
Puddling	84	56	.....	.....	6	6
Rolling (hand)	103	81	.....	.....	38	38
Yards	52	41	.....	.....	8	8
Mechanical	9	7	.....	.....	1	1
Other	9	7	.....	.....	5	5
Total	257	192	.....	.....	58	58
Plant No. 22:						
Steel foundry	465	477	.....	1	19	20
Other	86	63	.....	.....	9	9
Total	551	540	.....	1	28	29
Plant No. 23:						
Blast furnace	307	377	2	.....	30	32

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APPENDIX A.—NUMBER OF POSITIONS, 300-DAY WORKERS, AND ACCIDENTS RESULTING IN FATAL, PERMANENT, AND TEMPORARY INJURIES IN EACH OF 155 PLANTS, BY DEPARTMENTS, YEAR ENDING JUNE 30, 1910—Continued.

Plants and departments.	Positions.	300-day workers.	Accidents.			
			Fatal.	Permanent injury.	Temporary disability 1 day and over.	Total.
Plant No. 24:						
Open hearth	47	39	.....	.....	8	8
Rolling (mechanical)	22	7	.....	.....	2	2
Rolling (hand)	108	79	.....	1	22	23
Yards	54	37	.....	.....	32	32
Mechanical	88	59	.....	.....	9	9
Other	261	180	.....	.....	18	18
Total	580	401	.....	1	91	92
Plant No. 25:						
Blast furnace	240	266	.....	.....	35	35
Plant No. 26:						
Open hearth	59	70	.....	2	2	4
Rolling (hand)	79	55	.....	.....	3	3
Yards	99	89	.....	.....	13	13
Mechanical	78	70	.....	1	21	22
Other	299	267	.....	.....	37	37
Total	614	551	.....	3	76	79
Plant No. 27:						
Open hearth	87	103	.....	.....	13	13
Rolling (mechanical)	22	20	.....	.....	5	5
Rolling (hand)	229	211	.....	.....	26	26
Yards	119	117	.....	.....	6	6
Mechanical	75	72	.....	1	7	8
Other	81	70	.....	.....	19	19
Total	613	593	.....	1	76	77
Plant No. 28:						
Rolling (mechanical)	37	32	.....	.....	2	2
Other	204	203	.....	.....	20	20
Total	241	235	.....	.....	22	22
Plant No. 29:						
Open hearth	119	122	.....	.....	11	11
Rolling (mechanical)	44	39	.....	1	.....	1
Mechanical	9	7	.....	.....	1	1
Other	85	83	1	1	29	31
Total	257	251	1	2	41	44
Plant No. 30:						
Steel foundry	362	246	.....	2	307	309
Plant No. 31:						
Open hearth	40	36	.....	.....	6	6
Yards	272	289	.....	.....	10	10
Mechanical	79	61	.....	.....	12	12
Other	275	206	.....	1	27	28
Total	766	592	.....	1	55	56
Plant No. 32:						
Blast furnace	154	110	2	.....	120	122
Plant No. 33:						
Blast furnace	356	369	1	3	29	33
Plant No. 34:						
Blast furnace	142	172	1	1	19	21
Plant No. 35:						
Blast furnace	132	62	.....	1	38	39
Plant No. 36:						
Blast furnace	173	158	.....	.....	13	13

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APPENDIX A.—NUMBER OF POSITIONS, 300-DAY WORKERS, AND ACCIDENTS RESULTING IN FATAL, PERMANENT, AND TEMPORARY INJURIES IN EACH OF 155 PLANTS, BY DEPARTMENTS, YEAR ENDING JUNE 30, 1910—Continued.

Plants and departments.	Positions.	300-day workers.	Accidents.			
			Fatal.	Permanent injury.	Temporary disability 1 day and over.	Total.
Plant No. 37:						
Blast furnace	495	578	1	.....	42	43
Plant No. 38:						
Blast furnace	322	392	4	.....	16	20
Plant No. 39:						
Open hearth	134	145	.....	1	21	22
Rolling (mechanical)	124	98	1	.....	19	20
Yards	16	15	.....	1	11	12
Mechanical	48	45	.....	1	13	14
Other	25	24	.....	.....	.....	.....
Total	347	327	1	3	64	68
Plant No. 40:						
Rolling (hand)	153	138	.....	1	7	8
Other	194	164	.....	.....	40	40
Total	347	302	.....	1	47	48
Plant No. 41:						
Rolling (hand)	137	74	.....	.....	3	3
Other	196	148	.....	4	48	52
Total	333	222	.....	4	51	55
Plant No. 42:						
Blast furnace	457	556	1	.....	95	96
Plant No. 43:						
Blast furnace	456	452	1	2	131	134
Plant No. 44:						
Rolling (hand)	261	180	.....	.....	10	10
Yards	45	31	.....	.....	5	5
Mechanical	22	15	.....	.....	.....	.....
Other	14	10	.....	.....	3	3
Total	342	236	.....	.....	18	18
Plant No. 45:						
Steel foundry	372	365	.....	1	11	12
Other	135	135	.....	.....	8	8
Total	507	500	.....	1	19	20
Plant No. 46:						
Rolling (hand)	92	84	.....	.....	8	8
Plant No. 47:						
Blast furnace	231	172	1	.....	24	25
Plant No. 48:						
Steel foundry	587	597	.....	2	35	37
Other	657	603	1	1	76	78
Total	1,244	1,200	1	3	111	115
Plant No. 49:						
Open hearth	16	13	.....	.....	5	5
Steel foundry	117	117	.....	.....	40	40
Total	133	130	.....	.....	45	45
Plant No. 50:						
Blast furnace	163	127	1	.....	9	10

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APPENDIX A.—NUMBER OF POSITIONS, 300-DAY WORKERS, AND ACCIDENTS RESULTING IN FATAL, PERMANENT, AND TEMPORARY INJURIES IN EACH OF 155 PLANTS, BY DEPARTMENTS, YEAR ENDING JUNE 30, 1910—Continued.

Plants and departments.	Positions.	300-day workers.	Accidents.			
			Fatal.	Permanent injury.	Temporary disability 1 day and over.	Total.
Plant No. 51:						
Rolling (hand)	143	110	.....	.....	1	1
Other	33	20	.....	2	9	11
Total	176	130	.....	2	10	12
Plant No. 52:						
Puddling	9	8	.....	.....	4	4
Rolling (hand)	78	51	.....	.....	7	7
Other	82	76	.....	2	42	44
Total	169	135	.....	2	53	55
Plant No. 53:						
Open hearth	63	35	.....	.....	1	1
Steel foundry	630	586	.....	.....	66	66
Other	194	169	.....	2	24	26
Total	887	790	.....	2	91	93
Plant No. 54:						
Rolling (hand)	80	65	.....	1	4	5
Other	259	235	1	.....	20	21
Total	339	300	1	1	24	26
Plant No. 55:						
Entire plant	262	85	.....	.....	14	14
Plant No. 56:						
Entire plant	815	325	.....	4	66	70
Plant No. 57:						
Blast furnace	350	272	1	2	162	165
Other	4,992	5,189	3	12	1,551	1,566
Total	5,342	5,461	4	14	1,713	1,731
Plant No. 58:						
Entire plant	827	421	.....	2	116	118
Plant No. 59:						
Blast furnace	400	354	.....	2	165	167
Other	5,705	5,783	4	13	697	714
Total	6,105	6,137	4	15	862	881
Plant No. 60:						
Blast furnace	121	49	.....	1	44	45
Other	1,879	999	.....	1	196	197
Total	2,000	1,048	.....	2	240	242
Plant No. 61:						
Blast furnace	754	817	4	.....	192	196
Bessemer	357	273	1	.....	61	62
Rolling (mechanical)	625	500	1	.....	121	122
Yards	475	442	.....	.....	22	22
Mechanical	1,014	943	1	1	83	85
Iron foundry	263	268	.....	.....	50	50
Other	280	260	3	.....	95	98
Total	3,768	3,503	10	1	624	635
Plant No. 62:						
Blast furnace	378	318	1	.....	88	89
Plant No. 63:						
Blast furnace	288	248	1	.....	92	93

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APPENDIX A.—NUMBER OF POSITIONS, 300-DAY WORKERS, AND ACCIDENTS RESULTING IN FATAL, PERMANENT, AND TEMPORARY INJURIES IN EACH OF 155 PLANTS, BY DEPARTMENTS, YEAR ENDING JUNE 30, 1910—Continued.

Plants and departments.	Positions.	300-day workers.	Accidents.			
			Fatal.	Permanent injury.	Temporary disability 1 day and over.	Total.
Plant No. 64:						
Blast furnace	161	146	1	.....	161	162
Open hearth	347	344	1	.....	136	137
Rolling (mechanical)	281	205	.....	.....	107	107
Yards	412	363	.....	.....	17	17
Mechanical	400	352	.....	.....	82	82
Other	226	259	.....	.....	102	102
Total	1,827	1,669	2	.....	605	607
Plant No. 65:						
Blast furnace	175	117	1	.....	56	57
Open hearth	121	79	.....	.....	57	57
Rolling (mechanical)	59	35	1	.....	18	19
Rolling (hand)	71	42	.....	.....	15	15
Yards	100	64	.....	.....	2	2
Mechanical	132	84	.....	.....	20	20
Other	103	66	.....	.....	45	45
Total	761	487	2	.....	213	215
Plant No. 66:						
Blast furnace	392	365	1	.....	198	199
Open hearth	875	887	3	2	285	290
Rolling (mechanical)	388	389	1	1	136	138
Rolling (hand)	432	420	.....	1	165	166
Yards	533	526	4	1	20	25
Mechanical	1,104	1,089	2	.....	196	198
Other	388	509	.....	.....	157	157
Total	4,112	4,185	11	5	1,157	1,173
Plant No. 67:						
Blast furnace	308	341	.....	1	89	90
Bessemer	195	165	1	.....	53	54
Rolling (mechanical)	130	109	2	.....	57	59
Yards	96	77	.....	.....	1	1
Mechanical	158	127	.....	.....	30	30
Other	82	66	.....	.....	46	46
Total	969	885	3	1	276	280
Plant No. 68:						
Blast furnace	1,005	1,213	2	2	207	211
Bessemer	178	114	1	.....	61	62
Open hearth	1,514	1,509	3	2	507	512
Rolling (mechanical)	2,014	1,964	1	3	705	709
Rolling (hand)	65	63	.....	.....	24	24
Yards	1,361	1,360	7	.....	89	96
Mechanical	934	934	2	.....	229	231
Iron foundry	112	101	.....	.....	36	36
Other	834	851	3	.....	231	234
Total	8,017	8,109	19	7	2,089	2,115
Plant No. 69:						
Rolling (hand)	409	336	.....	.....	57	57
Yards	102	84	.....	.....	12	12
Mechanical	40	33	.....	.....	2	2
Other	75	90	.....	.....	8	8
Total	626	543	.....	.....	79	79
Plant No. 70:						
Rolling (mechanical)	377	274	1	1	76	78
Rolling (hand)	384	356	1	.....	114	115
Yards	157	115	.....	.....	58	58
Mechanical	124	90	1	.....	33	34
Other	99	16	.....	.....	34	34
Total	1,141	851	3	1	315	319

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APPENDIX A.—NUMBER OF POSITIONS, 300-DAY WORKERS, AND ACCIDENTS RESULTING IN FATAL, PERMANENT, AND TEMPORARY INJURIES IN EACH OF 155 PLANTS, BY DEPARTMENTS, YEAR ENDING JUNE 30, 1910—Continued.

Plants and departments.	Positions.	300-day workers.	Accidents.			
			Fatal.	Permanent injury.	Temporary disability 1 day and over.	Total.
Plant No. 71:						
Rolling (mechanical)	122	78	.....	.....	50	50
Rolling (hand)	308	241	.....	.....	87	87
Yards	106	80	1	.....	7	8
Mechanical	60	45	.....	.....	15	15
Other	34	25	.....	.....	38	38
Total	632	469	1	.....	197	198
Plant No. 72:						
Rolling (hand)	636	543	.....	.....	328	328
Yards	351	300	.....	.....	21	21
Mechanical	117	100	.....	.....	15	15
Other	183	155	.....	.....	66	66
Total	1,287	1,098	.....	.....	430	430
Plant No. 73:						
Rolling (hand)	436	393	.....	.....	189	189
Yards	288	260	.....	.....	25	25
Mechanical	92	83	.....	.....	19	19
Other	77	70	.....	.....	80	80
Total	893	806	.....	.....	313	313
Plant No. 74:						
Rolling (hand)	264	202	.....	.....	117	117
Yards	60	46	.....	.....	4	4
Mechanical	52	40	.....	.....	22	22
Total	376	288	.....	.....	143	143
Plant No. 75:						
Rolling (hand)	435	308	.....	.....	123	123
Other	281	217	.....	.....	63	63
Total	716	525	.....	.....	186	186
Plant No. 76:						
Blast furnace	286	200	.....	.....	51	51
Bessemer	204	112	1	.....	91	92
Rolling (mechanical)	93	50	.....	.....	31	31
Yards	18	11	.....	.....	3	3
Mechanical	64	40	.....	.....	10	10
Other	71	58	.....	.....	17	17
Total	736	471	1	.....	203	204
Plant No. 77:						
Rolling (hand)	159	145	.....	.....	21	21
Other	52	52	.....	.....	18	18
Total	211	197	.....	.....	39	39
Plant No. 78:						
Rolling (hand)	351	307	.....	.....	117	117
Yards	151	129	1	.....	4	5
Mechanical	38	32	.....	.....	4	4
Other	27	49	.....	.....	29	29
Total	567	517	1	.....	154	155
Plant No. 79:						
Blast furnace	417	448	1	1	150	152
Bessemer	275	238	2	1	117	120
Open hearth	326	324	2	1	158	161
Rolling (mechanical)	377	364	2	.....	118	120
Yards	553	559	2	.....	12	14
Mechanical	772	780	1	.....	152	153
Other	233	194	1	.....	149	150
Total	2,953	2,907	11	3	856	870

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APPENDIX A.—NUMBER OF POSITIONS, 300-DAY WORKERS, AND ACCIDENTS RESULTING IN FATAL, PERMANENT, AND TEMPORARY INJURIES IN EACH OF 155 PLANTS, BY DEPARTMENTS, YEAR ENDING JUNE 30, 1910—Continued.

Plants and departments.	Positions.	300-day workers.	Accidents.			
			Fatal.	Permanent injury.	Temporary disability 1 day and over.	Total.
Plant No. 80:						
Blast furnace	329	273	2	1	234	237
Bessemer	201	182	.....	.....	90	90
Rolling (mechanical)	166	134	.....	.....	58	58
Rolling (hand)	82	65	.....	.....	30	30
Yards	263	221	.....	.....	6	6
Mechanical	245	206	.....	.....	41	41
Other	108	191	.....	.....	90	90
Total	1,394	1,272	2	1	549	552
Plant No. 81:						
Blast furnace	375	346	1	1	252	254
Bessemer	282	268	1	.....	106	107
Rolling (mechanical)	195	187	.....	.....	116	116
Yards	125	118	.....	.....	73	73
Mechanical	254	240	1	.....	136	137
Other	145	137	.....	.....	111	111
Total	1,376	1,296	3	1	794	798
Plant No. 82:						
Blast furnace	166	157	.....	.....	69	69
Open hearth	281	300	1	.....	71	72
Rolling (mechanical)	345	297	.....	1	140	141
Rolling (hand)	83	80	.....	.....	32	32
Yards	364	354	1	1	15	17
Mechanical	380	370	1	.....	67	68
Other	88	101	.....	.....	62	62
Total	1,707	1,659	3	2	456	461
Plant No. 83:						
Open hearth	100	69	1	1	39	41
Rolling (hand)	147	115	.....	.....	46	46
Other	123	106	.....	.....	25	25
Total	370	290	1	1	110	112
Plant No. 84:						
Rolling (hand)	105	90	.....	.....	19	19
Plant No. 85:						
Rolling (hand)	134	128	.....	.....	29	29
Plant No. 86:						
Rolling (hand)	116	100	.....	1	27	28
Plant No. 87:						
Rolling (hand)	52	28	.....	.....	18	18
Plant No. 88:						
Blast furnace	227	269	.....	2	41	43
Open hearth	271	276	2	3	49	54
Rolling (mechanical)	124	119	.....	.....	15	15
Rolling (hand)	194	162	.....	1	29	30
Other	503	538	2	2	22	26
Total	1,319	1,364	4	8	156	168
Plant No. 89:						
Blast furnace	164	196	.....	.....	47	47
Bessemer	199	193	.....	1	74	75
Open hearth	59	60	.....	.....	15	15
Rolling (mechanical)	79	77	.....	.....	12	12
Mechanical	259	272	1	.....	27	28
Other	106	112	.....	.....	.....	.....
Total	866	910	1	1	175	177

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APPENDIX A.—NUMBER OF POSITIONS, 300-DAY WORKERS, AND ACCIDENTS RESULTING IN FATAL, PERMANENT, AND TEMPORARY INJURIES IN EACH OF 155 PLANTS, BY DEPARTMENTS, YEAR ENDING JUNE 30, 1910—Continued.

Plants and departments.	Positions.	300-day workers.	Accidents.			
			Fatal.	Permanent injury.	Temporary disability 1 day and over.	Total.
Plant No. 90:						
Blast furnace	422	502	.....	1	122	123
Plant No. 91:						
Blast furnace	100	40	2	.....	18	20
Bessemer	216	207	.....	2	51	53
Open hearth	92	92	.....	1	61	62
Rolling (mechanical)	183	181	.....	.....	55	55
Rolling (hand)	118	101	.....	.....	63	63
Other	345	284	.....	.....	.....	.....
Total	1,054	905	2	3	248	253
Plant No. 92:						
Rolling (hand)	125	106	1	1	48	50
Plant No. 93:						
Rolling (hand)	102	98	.....	2	24	26
Plant No. 94:						
Rolling (hand)	116	102	.....	.....	40	40
Plant No. 95:						
Rolling (hand)	201	139	1	1	84	86
Plant No. 96:						
Rolling (hand)	118	69	.....	.....	51	51
Plant No. 97:						
Rolling (hand)	42	24	.....	.....	15	15
Plant No. 98:						
Rolling (hand)	154	120	.....	2	43	45
Other	448	199	.....	.....	108	108
Total	602	319	.....	2	151	153
Plant No. 99:						
Blast furnace	516	511	2	2	122	126
Open hearth	332	343	.....	2	107	109
Rolling (mechanical)	576	592	1	2	329	332
Yards	1,169	1,188	3	.....	249	252
Mechanical	1,275	1,296	1	4	377	382
Other	193	201	.....	.....	48	48
Total	4,061	4,131	7	10	1,232	1,249
Plant No. 100:						
Blast furnace	160	173	.....	.....	29	29
Plant No. 101:						
Blast furnace	308	307	1	.....	49	50
Bessemer	269	270	1	.....	86	87
Rolling (mechanical)	261	262	1	1	98	100
Rolling (hand)	533	384	1	.....	53	54
Yards	456	409	.....	1	80	81
Mechanical	574	504	1	1	93	95
Other	236	212	.....	1	89	90
Total	2,637	2,348	5	4	548	557
Plant No. 102:						
Blast furnace	106	86	1	.....	31	32
Rolling (mechanical)	564	529	.....	1	123	124
Yards	125	115	.....	.....	51	51
Mechanical	245	225	.....	1	33	34
Other	141	129	.....	.....	.....	.....
Total	1,181	1,084	1	2	238	241

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APPENDIX A.—NUMBER OF POSITIONS, 300-DAY WORKERS, AND ACCIDENTS RESULTING IN FATAL, PERMANENT, AND TEMPORARY INJURIES IN EACH OF 155 PLANTS, BY DEPARTMENTS, YEAR ENDING JUNE 30, 1910—Continued.

Plants and departments.	Positions.	300-day workers.	Accidents.			
			Fatal.	Permanent injury.	Temporary disability 1 day and over.	Total.
Plant No. 103:						
Blast furnace	1,188	1,208	3	1	196	200
Bessemer	351	338	1	1	89	91
Open hearth	804	828	1	.....	191	192
Rolling (mechanical)	2,054	1,961	3	2	373	378
Yards	957	884	3	1	129	133
Mechanical	1,255	1,259	1	.....	107	108
Iron foundry	510	505	.....	.....	127	127
Other	423	509	.....	.....	58	58
Total	7,542	7,642	12	5	1,270	1,287
Plant No. 104:						
Blast furnace	478	416	3	.....	115	118
Open hearth	733	613	7	3	311	321
Rolling (mechanical)	1,089	1,004	3	3	223	229
Yards	998	915	5	1	80	86
Mechanical	1,945	1,888	.....	2	152	154
Foundry	229	231	1	1	26	28
Other	1,088	1,158	1	1	62	64
Total	6,560	6,225	20	11	969	1,000
Plant No. 105:						
Rolling (hand)	236	154	.....	.....	100	100
Puddling	187	151	.....	.....	15	15
Yards	381	275	.....	.....	30	30
Mechanical	105	76	1	1	16	18
Other	47	34	.....	3	11	14
Total	956	690	1	4	172	177
Plant No. 106:						
Rolling (mechanical)	208	198	.....	.....	23	23
Other	928	908	5	5	203	213
Total	1,136	1,106	5	5	226	236
Plant No. 107:						
Blast furnace	108	131	1	.....	35	36
Plant No. 108:						
Blast furnace	663	710	.....	2	70	72
Plant No. 109:						
Rolling (hand)	672	487	1	1	59	61
Yards	316	229	.....	.....	8	8
Mechanical	85	61	.....	.....	15	15
Other	39	29	.....	2	13	15
Total	1,112	806	1	3	95	99
Plant No. 110:						
Blast furnace	133	133	1	.....	22	23
Plant No. 111:						
Blast furnace	94	96	.....	.....	7	7
Plant No. 112:						
Rolling (hand)	235	149	.....	2	66	68
Puddling	121	100	.....	.....	2	2
Yards	88	62	.....	.....	9	9
Mechanical	74	52	1	1	93	95
Other	65	46	.....	.....	41	41
Total	583	409	1	3	211	215
Plant No. 113:						
Rolling (hand)	98	75	.....	.....	27	27
Yards	201	155	.....	.....	8	8
Mechanical	29	22	.....	.....	7	7
Other	48	37	.....	1	15	16
Total	376	289	.....	1	57	58

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APPENDIX A.—NUMBER OF POSITIONS, 300-DAY WORKERS, AND ACCIDENTS RESULTING IN FATAL, PERMANENT, AND TEMPORARY INJURIES IN EACH OF 155 PLANTS, BY DEPARTMENTS, YEAR ENDING JUNE 30, 1910—Continued.

Plants and departments.	Positions.	300-day workers.	Accidents.			
			Fatal.	Permanent injury.	Temporary disability 1 day and over.	Total.
Plant No. 114:						
Rolling (hand)	186	119	.....	3	64	67
Puddling	130	115	.....	.....	9	9
Yards	265	163	.....	.....	45	45
Mechanical	39	29	.....	.....	12	12
Other	18	13	.....	3	8	11
Total	638	439	.....	6	138	144
Plant No. 115:						
Blast furnace	720	876	.....	3	259	262
Plant No. 116:						
Blast furnace	523	549	5	1	125	131
Bessemer	363	432	3	3	104	110
Open hearth	452	545	1	6	135	142
Rolling (mechanical)	1,579	1,583	4	21	368	393
Rolling (hand)	197	191	.....	3	56	59
Yards	867	866	5	11	229	245
Mechanical	927	924	2	9	103	114
Iron foundry	142	142	.....	.....	28	28
Other	332	340	2	4	107	113
Total	5,382	5,572	22	58	1,255	1,335
Plant No. 117:						
Rolling (hand)	164	166	.....	.....	11	11
Other	193	131	.....	.....	8	8
Total	357	297	.....	.....	19	19
Plant No. 118:						
Blast furnace	227	186	2	.....	23	25
Plant No. 119:						
Rolling (hand)	99	76	.....	.....	2	2
Other	745	571	2	4	30	36
Total	844	647	2	4	32	38
Plant No. 120:						
Open hearth	166	157	.....	.....	9	9
Rolling (mechanical)	81	63	.....	.....	2	2
Rolling (hand)	115	70	.....	1	18	19
Yards	238	191	.....	.....	42	42
Mechanical	133	107	.....	.....	9	9
Other	482	387	.....	6	26	32
Total	1,215	975	.....	7	106	113
Plant No. 121:						
Yards	149	156	.....	.....	12	12
Mechanical	105	110	.....	.....	9	9
Steel foundry	355	306	1	2	108	111
Other	112	123	.....	.....	3	3
Total	721	695	1	2	132	135
Plant No. 122:						
Steel foundry	2,189	2,361	2	4	341	347
Other	218	235	.....	4	76	80
Total	2,407	2,596	2	8	417	427
Plant No. 123:						
Steel foundry	183	134	.....	2	38	40
Other	46	34	.....	.....	9	9
Total	229	168	.....	2	47	49

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APPENDIX A.—NUMBER OF POSITIONS, 300-DAY WORKERS, AND ACCIDENTS RESULTING IN FATAL, PERMANENT, AND TEMPORARY INJURIES IN EACH OF 155 PLANTS, BY DEPARTMENTS, YEAR ENDING JUNE 30, 1910—Continued.

Plants and departments.	Positions.	300-day workers.	Accidents.			
			Fatal.	Permanent injury.	Temporary disability 1 day and over.	Total.
Plant No. 124:						
Steel foundry	470	414	.....	.....	10	10
Other	147	126	.....	.....	1	1
Total	617	540	.....	.....	11	11
Plant No. 125:						
Steel foundry	487	516	.....	2	46	48
Other	163	173	.....	2	10	12
Total	650	689	.....	4	56	60
Plant No. 126:						
Steel foundry	146	123	.....	1	34	35
Other	94	79	.....	.....	3	3
Total	240	202	.....	1	37	38
Plant No. 127:						
Yards	110	117	.....	.....	25	25
Mechanical	138	147	.....	.....	46	46
Steel foundry	882	867	1	2	407	410
Total	1,130	1,131	1	2	478	481
Plant No. 128:						
Yards	209	177	.....	.....	8	8
Mechanical	66	56	.....	.....	11	11
Steel foundry	758	642	.....	4	194	198
Other	33	28	.....	.....	5	5
Total	1,066	903	.....	4	218	222
Plant No. 129:						
Blast furnace	288	252	2	1	61	64
Plant No. 130:						
Blast furnace	172	209	1	.....	27	28
Plant No. 131:						
Open hearth	405	408	.....	3	161	164
Rolling (mechanical)	523	445	.....	.....	126	126
Yards	209	192	.....	.....	50	50
Mechanical	131	121	.....	.....	37	37
Other	4	4	.....	.....	.....	.....
Total	1,272	1,170	.....	3	374	377
Plant No. 132:						
Blast furnace	771	783	2	5	385	392
Bessemer	418	346	1	2	384	387
Open hearth	487	593	2	3	480	485
Rolling (mechanical)	1,597	1,371	3	2	539	544
Rolling (hand)	1,332	1,317	2	4	908	914
Yards	2,024	1,936	5	1	482	488
Mechanical	2,827	2,704	3	7	1,397	1,407
Other	707	676	6	1	520	527
Total	10,163	9,726	24	25	5,095	5,144
Plant No. 133:						
Blast furnace	899	1,013	3	8	107	118
Yards	1,212	1,239	1	4	94	99
Other	4,590	4,581	10	13	1,740	1,763
Total	6,701	6,833	14	25	1,941	1,980
Plant No. 134:						
Open hearth	157	157	2	2	49	53
Rolling (mechanical)	89	85	.....	.....	4	4
Other	2,179	1,585	2	5	103	110
Total	2,425	1,827	4	7	156	167

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APPENDIX A.—NUMBER OF POSITIONS, 300-DAY WORKERS, AND ACCIDENTS RESULTING IN FATAL, PERMANENT, AND TEMPORARY INJURIES IN EACH OF 155 PLANTS, BY DEPARTMENTS, YEAR ENDING JUNE 30, 1910—Continued.

Plants and departments.	Positions.	300-day workers.	Accidents.			
			Fatal.	Permanent injury.	Temporary disability 1 day and over.	Total.
Plant No. 135:						
Rolling (hand)	111	81	.....	.....	12	12
Other	313	230	.....	.....	46	46
Total	424	311	.....	.....	58	58
Plant No. 136:						
Blast furnace	214	220	.....	1	49	50
Plant No. 137:						
Blast furnace	102	121	.....	.....	14	14
Plant No. 138:						
Blast furnace	193	148	.....	.....	42	42
Bessemer	395	393	1	1	65	67
Rolling (hand)	103	102	3	.....	16	19
Puddling	275	193	.....	.....	10	10
Yards	675	563	4	.....	118	122
Mechanical	711	597	2	.....	191	193
Other	1,856	1,373	1	13	212	226
Total	4,208	3,369	11	14	654	679
Plant No. 139:						
Entire plant	347	340	.....	3	92	95
Plant No. 140:						
Open hearth	200	222	.....	.....	12	12
Rolling (hand)	66	64	.....	.....	5	5
Other	244	246	.....	.....	59	59
Total	510	532	.....	.....	76	76
Plant No. 141:						
Puddling	42	33	.....	.....	2	2
Other	20	15	.....	.....	.....	.....
Total	62	48	.....	.....	2	2
Plant No. 142:						
Entire plant	331	273	.....	2	21	23
Plant No. 143:						
Entire plant	219	185	.....	1	72	73
Plant No. 144:						
Entire plant	954	782	.....	4	46	50
Plant No. 145:						
Blast furnace	248	288	.....	2	86	88
Bessemer	133	137	2	.....	93	95
Rolling (mechanical)	100	103	3	.....	21	24
Rolling (hand)	351	363	.....	1	164	165
Yards	179	191	2	.....	115	117
Mechanical	254	271	.....	1	103	104
Other	131	138	.....	1	7	8
Total	1,396	1,491	7	5	589	601
Plant No. 146:						
Rolling (hand)	174	180	1	.....	83	84
Plant No. 147:						
Puddling	152	173	.....	.....	3	3
Rolling (hand)	219	180	.....	.....	65	65
Other	252	267	.....	.....	32	32
Total	623	620	.....	.....	100	100

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APPENDIX A.—NUMBER OF POSITIONS, 300-DAY WORKERS, AND ACCIDENTS RESULTING IN FATAL, PERMANENT, AND TEMPORARY INJURIES IN EACH OF 155 PLANTS, BY DEPARTMENTS, YEAR ENDING JUNE 30, 1910—Concluded.

Plants and departments.	Positions.	300-day workers.	Accidents.			
			Fatal.	Permanent injury.	Temporary disability 1 day and over.	Total.
Plant No. 148:						
Puddling	170	199	.....	.....	2	2
Other	360	334	.....	.....	41	41
Total	530	583	.....	.....	43	43
Plant No. 149:						
Steel foundry	124	114	.....	.....	16	16
Plant No. 150:						
Puddling	123	147	.....	.....	6	6
Steel foundry	549	538	.....	1	39	40
Other	349	140	.....	.....	45	45
Total	1,021	825	.....	1	90	91
Plant No. 151:						
Steel foundry	236	218	1	.....	31	32
Plant No. 152:						
Steel foundry	709	607	.....	.....	33	33
Other	384	329	.....	1	25	26
Total	1,093	936	.....	1	58	59
Plant No. 153:						
Steel foundry	293	292	.....	1	71	72
Plant No. 154:						
Steel foundry	106	69	.....	.....	1	1
Plant No. 155:						
Steel foundry	97	92	.....	.....	4	4

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APPENDIX B.—ACCIDENTS AND TIME LOST, BY DEPARTMENTS AND OCCUPATIONS, IN 130 PLANTS FOR 2 YEARS ENDING JUNE 30, 1910.

Departments and occupations.	Total number of accidents.	Accidents for which time lost was reported.	
		Number.	Aggregate days lost.
BLAST FURNACES.			
Bar and clay men	7	5	66
Blacksmiths	7	6	73
Blacksmiths' helpers	3	1	2
Blowers	4	2	28
Boiler makers	15	4	50
Boiler makers' helpers	17	2	11
Bottom fillers	146	130	1,923
Bricklayers	8	1	4
Bricklayers' helpers	1		
Cagers	7	7	85
Carpenters	27	16	165
Carpenters' helpers	5	5	65
Cinder men	32	30	913
Cinder snappers	30	25	291
Crane hookers	31	25	281
Cranemen	7	7	86
Dustmen	5	3	64
Engineers, blowing	1	1	36
Foremen	28	24	192
Handy men	6	6	56
Hookers on, pig breaker	1	1	20
Iron graders	5	2	7
Keepers	38	30	337
Keepers' helpers	183	146	1,931
Laborers	932	618	7,928
Ladle men	16	10	120
Larry men	6	6	129
Lever men	2		
Loaders	1		
Machinists	39	25	245
Machinists' helpers	21	16	108
Master mechanics	3		
Millwrights	4	2	3
Oilers and greasers	19	12	163
Painters	3	3	22
Pattern makers	1	1	7
Pig-breaker operators	1	1	2
Pig-machine men	12	11	122
Pipe fitters	13	8	26
Pipe fitters' helpers	4	1	4
Repair men	3	2	26
Repair men's helpers	2	2	4
Riggers	6	3	11
Riggers' helpers	1	1	7
Roofers	1		
Scale-car operators	4	4	40
Scrap men	32	23	414
Skip-hoist operators	4	2	33
Stockers	9	9	176
Stove cleaners	2	2	41
Stove tenders	32	26	319
Top fillers	29	24	531
Weighers	1		
Unclassified	35	18	322
Not reported	8	8	55
Total	1,860	1,317	17,544
BESSEMER STEEL WORKS.			
Blowers	2	1	14
Bottom-house men	2	1	7
Bottom makers	1	1	37
Chargers' helpers	1	1	9
Cinder men	9	3	12
Cranemen	3	3	18
Cupola chargers	3	3	18
Cupola liners	1	1	15
Foremen	6	5	126
Iron pourers	1	1	7
Laborers	216	205	2,962

Departments and occupations.	Total number of accidents.	Accidents for which time lost was reported.	
		Number.	Aggregate days lost.
BESSEMER STEEL WORKS—concluded.			
Ladle men	35	34	465
Ladle men's helpers	4	1	5
Melters	1	1	15
Mixer men	1	1	34
Mold-car cleaners	1		
Oilers	2		
Runner men	2	2	54
Scrap men	3	2	28
Stage men	22	22	288
Steel pourers	4	3	32
Stockers	7	5	148
Stopper setters	5	4	49
Tappers	4	2	70
Vessel men	13	10	121
Vessel men's helpers	13	11	328
Weighers	2	2	13
Unclassified	9	5	47
Not reported	9	4	108
Total	382	334	5,020
OPEN-HEARTH STEEL WORKS.			
Chargers	4	4	29
Charging-car operators	2	2	28
Cinder men	1		
Crane hookers	2	2	37
Cranemen	11	10	205
Door operators	3	2	22
Firemen	1	1	12
Foremen	28	26	359
Gas makers	13	12	69
Laborers	227	191	2,758
Ladle men	32	28	225
Ladle men's helpers	4	4	39
Lever men	2	1	7
Melters	3	3	84
Melters' helpers	105	91	1,126
Mold cappers	8	6	126
Mold-car cleaners	1	1	6
Oilers	2	2	24
Pitmen	169	138	2,209
Shearmen	1	1	6
Steel pourers	5	4	20
Stockers	122	113	1,416
Switchmen	1	1	2
Weighers	3	2	18
Unclassified	9	9	113
Not reported	2	2	18
Total	761	656	9,028
BLOOMING MILLS.			
Bottom makers	2	2	14
Chargers	3	1	7
Cinder men	1	1	6
Crane hookers	1	1	3
Cranemen	11	9	46
Door operators	1	1	1
Engineers, roll	6	4	40
Foremen	4	4	49
Gas makers	4	4	19
Guide setters	2	1	2
Heaters	2	2	26
Heaters' helpers	10	8	143
Hotbed men	1	1	37
Ingot-buggy operators	1	1	4
Laborers	38	30	562
Manipulators	1	1	3

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APPENDIX B.—ACCIDENTS AND TIME LOST, BY DEPARTMENTS AND OCCUPATIONS, IN 130 PLANTS FOR 2 YEARS ENDING JUNE 30, 1910—Continued.

Departments and occupations.	Total number of accidents.	Accidents for which time lost was reported.	
		Number.	Aggregate days lost.
BLOOMING MILLS—concd.			
Oilers	14	7	76
Rollers	3	3	37
Roll hands	5	3	67
Roughers	5	2	9
Shearmen	10	9	71
Shearmen's helpers	11	9	99
Stampers	2	2	19
Stockers	3	.....	.....
Table men	1	1	6
Tongs men	1	1	2
Unclassified	2	2	9
Total	145	110	1,357
SHEET MILLS.			
Bundlers	4	4	43
Catchers	20	18	211
Chargers	3	3	10
Cinder men	1	1	5
Crane hookers	1	1	8
Cranemen	7	6	123
Door operators	5	5	32
Doublers	18	13	122
Drag downs	1	.....	.....
Drag outs	2	2	15
Engineers, roll	3	3	18
Foremen	5	4	49
Heaters	19	14	182
Heaters' helpers	13	11	64
Laborers	79	50	735
Matchers	14	14	109
Oilers	1	1	6
Openers	26	20	356
Rollers	13	11	99
Roll hands	7	6	44
Roughers	15	12	139
Scrap men	10	6	45
Screw men	4	3	16
Shearmen	19	15	138
Shearmen's helpers	18	13	130
Stockers	4	3	106
Straighteners	1	.....	.....
Table men	1	1	11
Weighers	1	1	26
Unclassified	16	11	221
Total	331	252	3,063
PLATE MILLS.			
Catchers	1	.....	.....
Chargers	3	2	43
Chargers' helpers	1	1	9
Cinder men	1	1	7
Cranemen	1	1	51
Door operators	2	2	35
Engineers, roll	1	1	6
Foremen	1	1	28
Gas makers	1	1	7
Heaters	2	2	16
Heaters' helpers	9	9	85
Hook men	6	3	72
Laborers	79	61	864
Layers out	4	4	32
Lever men	2	2	25
Markers	3	2	42
Oilers	1	1	5
Rollers	6	6	175
Roll hands	7	7	64
Roughers	2	2	13
Scrap men	2	2	5
Screw men	3	2	12
Shearmen	82	82	1,157
Shearmen's helpers	20	17	279
Straighteners	3	3	11
Straighteners' helpers	2	2	15
Unclassified	11	11	161
Not reported	2	2	12
Total	258	230	3,231
TUBE MILLS.			
Ball cleaners	1	1	8
Ballers	8	8	152
Ballers' helpers	3	3	54
Bar pullers	2	2	10
Bell boys	3	2	33
Bell cleaners	3	3	19
Bench operators	1	1	4
Benders	2	2	176
Bundlers	5	5	318
Bundlers' helpers	1	1	166
Catchers	1	.....	.....
Chargers	7	6	42
Chargers' helpers	1	1	8
Clippers	2	1	11
Crane hookers	13	13	265
Cranemen	4	4	74
Cross rollers	2	2	21
Die setters	4	3	63
Doublers	1	1	5
Firemen	1	1	9
Foremen	2	2	36
Gas makers	15	15	177
Gas makers' helpers	1	1	2
Gaugers	1	1	6
Heaters	2	2	8
Heaters' helpers	5	3	61
Hook runners	14	9	193
Laborers	132	113	1,594
Lever men	3	3	289
Oilers	4	4	107
Piercers	2	1	7
Pipe carriers	1	1	5
Pipe cutters	86	78	989
Pipe cutters' helpers	14	14	253
Pipe patchers	1	1	5
Pipe stockers	1	1	16
Pipe testers	13	13	133
Pipe testers' helpers	6	6	62
Pipe truckers	8	8	111
Pipe welders	11	11	90
Reamers	1	1	72
Rollers	3	3	70
Roll hands	2	1	1
Roll setters	9	9	184
Saw men	1	1	20
Shearmen	4	4	58
Shearmen's helpers	2	2	9
Socket bellers	8	8	76
Socket benders and helpers	5	5	46
Socket expanders	1	1	98
Socket heaters and helpers	15	15	165
Socket makers	3	2	20

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APPENDIX B.—ACCIDENTS AND TIME LOST, BY DEPARTMENTS AND OCCUPATIONS, IN 130 PLANTS FOR 2 YEARS ENDING JUNE 30, 1910—Continued.

Departments and occupations.	Total number of accidents.	Accidents for which time lost was reported.	
		Number.	Aggregate days lost.
TUBE MILLS—concluded.			
Socket reamers	3	3	30
Socket tappers	11	9	91
Socket welders	3	3	10
Stockers	2	2	10
Straighteners	7	7	178
Table men	1	1	6
Tong carriers	2	2	14
Tong cleaners	1	1	5
Tongs men	1	.....	.....
Tong take-offs	5	5	140
Truckers	4	4	55
Welders	7	7	141
Unclassified	26	19	330
Total	514	462	7,411
BAR MILLS.			
Bundlers	1	1	3
Catchers	35	23	287
Catchers' helpers	1	1	7
Chargers	42	24	388
Chargers' helpers	1	1	4
Cinder men	32	19	256
Crane hookers	3	3	18
Cranemen	6	6	133
Cranemen's helpers	1	1	35
Door operators	14	6	43
Drag downs	55	39	322
Drag outs	24	16	199
Engineers, roll	3	3	8
Finishers	22	13	170
Foremen	17	13	132
Gas makers	1	1	13
Gaugers	10	2	15
Guide setters	3	1	4
Heaters	42	31	284
Heaters' helpers	39	26	212
Hookers	14	13	241
Hook ups	35	22	283
Hotbed men	25	20	230
Laborers	582	483	5,944
Lever men	4	3	24
Oilers and greasers	12	8	33
Reelers	1	1	10
Rollers	56	40	969
Rollers' helpers	1	1	19
Roll hands	213	191	2,325
Roughers	122	73	602
Saw men	1	1	15
Scrapers	5	5	134
Scrap men	11	4	26
Shearmen	188	118	1,217
Shearmen's helpers	99	73	542
Stockers	16	7	63
Straighteners	51	33	474
Straighteners' helpers	3	2	6
Stranders	79	51	709
Table men	2	2	5
Weighers	7	6	30
Unclassified	85	72	967
Not reported	166	165	1,807
Total	2,130	1,624	19,208
STRUCTURAL MILLS.			
Cinder men	1	1	1
Foremen	1	1	6
Hotbed men	1	1	1
Laborers	61	50	746
Lever men	1	1	12
Oilers and greasers	2	2	46
Rollers	3	2	26
Straighteners	3	3	16
Table men	2	2	21
Unclassified	5	5	71
Not reported	1	1	2
Total	81	69	948
FOUNDRIES.			
Chippers	840	336	2,770
Clampers	3	3	20
Cleaners	1	1	8
Core makers	52	24	152
Crane hookers	160	39	361
Cranemen	30	13	235
Cupola chargers	20	9	50
Cupola chargers' helpers	1	1	60
Cupola liners	1	1	15
Foremen	36	17	243
Gas makers	4	1	1
Grinders	166	72	436
Handy men	1	1	4
Inspectors	2	2	19
Laborers	604	334	3,573
Ladle men	15	11	91
Ladle men's helpers	12	5	33
Melters	2	2	8
Melters' helpers	33	15	219
Molders	303	190	2,292
Molders' helpers	286	103	1,389
Oilers	2	.....	.....
Pattern filers	24	.....	.....
Pattern filers' helpers	3	.....	.....
Rammers	66	2	15
Rammers' helpers	21	.....	.....
Rumblers	12	5	16
Sand blasters	15	10	63
Shake outs	11	7	33
Stockers	6	4	59
Tappers	1	1	28
Truckers	2	.....	.....
Wheel breakers	4	3	5
Wheel rollers	28	17	64
Unclassified	108	44	445
Not reported	22	10	62
Total	2,897	1,283	12,769
DOCK AND ORE YARDS.			
Laborers	38	34	345
Oilers	4	3	179
Ore-bridge operators	13	11	116
Samplers	2	2	13
Total	57	50	653
YARDS.			
Crane engineers	1	.....	.....
Crane hookers	10	8	429
Cranemen	23	18	292
Cranemen, locomotive	5	5	42
Drop men	18	13	178
Engineers, locomotive	12	10	303

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APPENDIX B.—ACCIDENTS AND TIME LOST, BY DEPARTMENTS AND OCCUPATIONS, IN 130 PLANTS FOR 2 YEARS ENDING JUNE 30, 1910—Continued.

Departments and occupations.	Total number of accidents.	Accidents for which time lost was reported.	
		Number.	Aggregate days lost.
YARDS—concluded.			
Firemen, locomotive	6	4	63
Foremen	48	36	660
Laborers	1,225	1,032	13,252
Loaders	71	53	541
Locomotive crane firemen	2	1	8
Locomotive crane switchmen	3	3	24
Painters	1	1	3
Repair men	1	1	22
Shearmen	3	2	11
Shippers	23	7	87
Stockers	17	10	303
Switchmen	235	172	3,207
Teamsters	60	34	476
Trackmen	3	2	25
Truckers	8	7	22
Yardmasters	8	5	27
Unclassified	23	17	202
Not reported	3	2	27
Total	1,809	1,443	20,304
ELECTRICAL.			
Electricians	59	45	1,289
Electricians' helpers	5	4	39
Engineers	1	1	10
Foremen	5	4	8
Inspectors	11	8	206
Laborers	1	1	4
Light trimmers	2	2	3
Linemen	9	6	52
Linemen's helpers	1	1	4
Motor men	3	1	21
Oilers	1	1	12
Repair men	1	1	8
Unclassified	2	1	7
Total	101	76	1,663
MECHANICAL.			
Blacksmiths	79	51	946
Blacksmiths' helpers	53	37	404
Boiler makers	33	21	400
Boiler makers' helpers	29	23	565
Bricklayers	44	36	599
Bricklayers' helpers	43	32	523
Carpenters	137	105	1,970
Carpenters' helpers	12	12	150
Crane hookers	1	1	4
Drillers	37	21	210
Drillers' helpers	10	4	18
Engineers	2	1	2
Foremen	11	9	45
Grinders	7	7	51
Handy men	104	98	838
Laborers	60	39	907
Machine hands	82	61	652
Machinists	308	226	2,361
Machinists' helpers	150	108	1,125
Master mechanics	5	5	67
Millwrights	76	60	1,001
Millwrights' helpers	32	24	280
Oilers	4	2	37
Painters	23	17	194
Pattern makers	20	15	270
Pattern makers' helpers	7	3	45
Pipe fitters	40	42	276
Pipe fitters' helpers	15	11	112
Plumbers	6	5	26
Reamers	1	1	4
Repair men	27	21	286
Repair men's helpers	4	4	15
Riggers	90	66	984
Riggers' helpers	3	3	76
Riveters	10	6	46
Riverters' helpers	11	10	169
Roll chippers	2	2	12
Roll turners	20	17	106
Roll turners' helpers	4	4	66
Shaper hands	1	1	3
Structural-iron workers	1	1	14
Unclassified	33	18	155
Not reported	9	8	72
Total	1,655	1,248	16,196
BOILER HOUSES AND ENGINE ROOMS.			
Boiler cleaners	20	13	92
Boiler inspectors	1	.....	.....
Engineers	79	57	730
Firemen	120	81	744
Firemen's helpers	1	.....	.....
Foremen	3	2	55
Laborers	62	47	917
Oilers	17	14	246
Pump men	7	7	56
Water tenders	23	10	250
Unclassified	4	4	193
Not reported	2	2	26
Total	339	237	3,309
FORGE SHOPS.			
Chargers	1	.....	.....
Chippers	8	8	59
Cranemen	2	2	6
Door operators	1	.....	.....
Hammermen	41	31	295
Hammermen's helpers	22	21	250
Heaters	15	14	118
Heaters' helpers	7	7	109
Laborers	54	39	454
Lever men	4	4	40
Oilers and greasers	1	.....	.....
Peg men	2	2	51
Shearmen	4	1	4
Shearmen's helpers	1	.....	.....
Tongs men	3	3	61
Welding hammermen	1	1	3
Unclassified	3	3	26
Not reported	2	.....	.....
Total	172	136	1,476
CRUCIBLE STEEL MAKING.			
Chippers	3	3	48
Cinder men	1	1	14
Cover operators	1	1	6
Gas makers	7	7	150
Laborers	19	17	171
Ladle men	3	2	105
Melters	3	2	11
Molders	22	18	231

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APPENDIX B.—ACCIDENTS AND TIME LOST, BY DEPARTMENTS AND OCCUPATIONS, IN 130 PLANTS FOR 2 YEARS ENDING JUNE 30, 1910—Concluded.

Departments and occupations.	Total number of accidents.	Accidents for which time lost was reported.	
		Number.	Aggregate days lost.
CRUCIBLE STEEL MAKING—concluded.			
Pot fillers	4	4	107
Pullers-out	26	26	788
Shaker men	6	5	33
Teamers	2	2	8
Toppers	9	9	88
Weighers	1	1	3
Unclassified	3	3	167
Total	110	101	1,930
COLD DRAWING.			
Drawbench men	4	3	121
Drawbench men's helpers	4	4	32
Foremen	1	1	12
Laborers	11	10	73
Shearmen	1	1	10
Total	21	19	248
COLD DRAWING AND ROLLING.			
Cleaners	1	.....	.....
Crane hookers	1	.....	.....
Drawbench men	5	1	14
Drawbench men's helpers	1	.....	.....
Laborers	2	.....	.....
Straighteners	2	2	116
Unclassified	1	.....	.....
Not reported	1	.....	.....
Total	14	3	130
PUDDLING.			
Bloom runners	2	2	31
Bushelers	25	18	151
Bushelers' helpers	5	4	20
Foremen	1	.....	.....
Laborers	22	18	349
Puddlers	98	73	2,018
Puddlers' helpers	8	7	106
Stockers	2	.....	.....
Unclassified	1	.....	.....
Total	164	122	2,675
WIRE MILLS.			
Barbed-wire operators	7	5	70
Bundlers	8	7	149
Chargers	1	1	3
Crane hookers	1	1	15
Cranemen	1	.....	.....
Die reamers	2	2	5
Fence makers	3	1	2
Fence makers' helpers	1	1	15
Gangers	3	3	95
Laborers	60	37	558
Loom operators	13	10	129
Loom operators' helpers	1	1	6
Nail-machine helpers	20	18	164
Nail-machine operators	12	12	108
Oilers and greasers	1	1	12
Pointers	3	.....	.....
Reelers	7	5	27
Reelers' helpers	2	2	6
Shearmen	5	2	51
Stockers	11	11	76
Straighteners	1	1	3
Truckers	12	12	163
Wire cleaners	1	1	16
Wire drawers	157	143	1,718
Wire drawers' helpers	2	2	30
Wire spoolers	4	3	6
Unclassified	27	23	223
Not reported	3	3	20
Total	369	308	3,671
MISCELLANEOUS.			
Chemists	6	5	69
Chemists' helpers	5	5	254
Chippers	12	12	121
Clerks	12	7	85
Flangers	2	2	17
Foremen	13	13	96
Grinders	6	4	53
Inspectors	39	29	340
Janitors	2	2	15
Laborers	290	236	3,608
Oilers	2	2	118
Policemen	6	3	28
Samplers	3	3	21
Shearmen	78	72	886
Shearmen's helpers	66	56	703
Shearmen, scrap	1	1	10
Shippers	1	1	5
Structural-iron workers	12	8	151
Truckers	22	21	352
Warehousemen	13	9	265
Watchmen	10	9	165
Weighers	5	5	16
Unclassified	192	161	2,186
Not reported	11	6	76
Total	809	672	9,640
NOT REPORTED.			
Bundlers	1	1	18
Engineers, roll	1	1	4
Firemen	1	1	25
Foremen	2	2	34
Inspectors	1	1	2
Janitors	2	2	37
Laborers	872	387	3,649
Stockers	2	2	40
Truckers	1	1	4
Watchmen	1	.....	.....
Unclassified	10	9	139
Not reported	555	543	5,431
Total	1,449	950	9,383

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APPENDIX C.—NATURE OF INJURY, BY DEPARTMENTS, IN 130 PLANTS FOR 2 YEARS ENDING JUNE 30, 1910.

NUMBER OF INJURIES.

Nature of injury.	Blast furnaces.	Steel works.	Rolling mills.	Foundries.	Yards.	Mechanical.	Miscellaneous.	Not reported.	Total.
PERMANENT INJURIES.									
Loss of one arm	.....	.....	3	2	1	4	.....	.....	10
Loss of one leg	1	1	1	2	5	2	.....	.....	12
Loss of one hand	1	.....	.....	2	.....	.....	3	2	8
Loss of both hands	.....	.....	.....	1	.....	.....	1	.....	2
Loss of thumb	.....	1	5	3	5	2	12	2	30
Loss of first finger	3	3	17	12	7	12	16	7	77
Loss of other fingers	11	10	37	24	16	28	26	15	167
Loss of one foot	1	2	4	.....	2	2	3	.....	14
Loss of one eye	4	3	7	9	6	6	10	4	49
Loss of both eyes	1	1	.....	.....	.....	.....	.....	.....	2
Total permanent injuries	22	21	74	55	42	56	71	30	371
TEMPORARY DISABILITIES.									
Other eye injuries	71	55	130	504	59	191	128	44	1,192
Fracture of one arm	5	2	14	11	9	11	13	5	70
Fracture of both arms	.....	.....	.....	.....	.....	1	.....	.....	1
Fracture of one leg	14	14	18	31	26	21	19	6	149
Fracture of both legs	.....	.....	.....	4	.....	1	1	.....	6
Fracture of skull	4	3	1	3	1	1	4	.....	17
Fracture of ribs	19	9	16	3	15	15	24	9	110
Other fractures	6	12	15	7	8	11	11	5	75
Hand crushed or broken	12	11	16	24	16	9	13	6	107
Foot or toes crushed or broken	80	60	132	145	97	51	82	98	745
Fingers crushed or broken	87	69	147	332	119	122	111	92	1,079
Hand or fingers bruised, cut, etc.	291	162	804	572	381	360	459	340	3,369
Foot or toes bruised, cut, etc.	233	109	417	330	325	148	189	177	1,928
Other bruises, cuts, etc	396	228	670	441	406	319	456	286	3,202
Dislocations	14	10	14	29	26	17	24	.....	134
Punctured wounds	33	17	94	56	41	71	76	31	419
Asphyxia	21	1	.....	1	1	.....	9	.....	33
Burns by hot metal	128	137	239	148	11	14	47	11	735
Burns by gas	8	6	4	4	.....	7	19	1	49
Burns by electricity	3	2	2	2	2	.....	17	.....	28
Burns by steam and water	25	10	13	4	16	11	47	5	131
Burns not specified	232	93	313	77	45	50	150	115	1,075
Hernia	4	.....	10	5	3	9	5	3	39
Plural injuries	25	19	57	38	41	42	29	21	272
Unclassified	125	89	254	67	114	117	141	154	1,061
Not reported	2	4	5	4	5	.....	1	10	31
Total temporary disabilities	1,838	1,122	3,385	2,842	1,767	1,599	2,085	1,419	16,057
Total nonfatal injuries	1,860	1,143	3,459	2,897	1,809	1,655	2,156	1,449	16,428

PER CENT OF INJURIES OF EACH NATURE.

Total permanent injuries	1.2	1.8	2.1	1.9	2.3	3.4	3.2	2.1	2.3
TEMPORARY DISABILITIES.									
Eye injuries	3.8	4.8	3.8	17.4	3.3	11.5	6.4	3.0	7.2
Fracture of one arm	.3	.2	.4	.4	.5	.7	.6	.3	.4
Fracture of both arms	.....	.....	.....	.....	.....	.1	.....	.....	.....
Fracture of one leg	.8	1.2	.5	1.1	1.4	1.3	.9	.4	.9
Fracture of both legs	.....	.....	.....	.1	.....	.1	.....	.....	.....
Fracture of skull	.2	.3	.3	.1	.1	.1	.2	.....	.1
Fracture of ribs	1.0	.8	.5	.1	.8	.9	1.1	.6	.7
Other fractures	.3	1.0	.4	.2	.4	.7	.5	.3	.5
Hand crushed or broken	.6	1.0	.5	.3	.9	.5	.6	.4	.7
Foot or toes crushed or broken	4.3	5.2	3.8	5.0	5.4	3.1	3.8	6.8	4.5
Fingers crushed or broken	4.7	6.0	4.2	11.5	6.6	7.4	5.1	6.3	6.6
Hand or fingers bruised, cut, etc.	15.6	14.2	23.2	19.8	21.1	21.3	21.3	23.5	20.4
Foot or toes bruised, cut, etc.	12.5	9.5	12.1	11.4	18.0	8.9	3.8	12.2	11.7
Other bruises, etc	21.3	19.9	19.4	15.2	22.4	19.3	21.1	19.7	19.5

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APPENDIX C.—NATURE OF INJURY, BY DEPARTMENTS, IN 130 PLANTS FOR 2 YEARS ENDING JUNE 30, 1910—Concluded.

PER CENT OF INJURIES OF EACH NATURE—Concluded.

Nature of injury.	Blast furnaces.	Steel works.	Rolling mills.	Foundries.	Yards.	Mechanical.	Miscellaneous.	Not reported.	Total.
Dislocations	0.8	0.9	0.4	1.0	1.4	1.0	1.1	.....	0.8
Punctured wounds	1.8	1.5	2.7	1.9	2.3	4.3	3.5	2.1	2.6
Asphyxia	1.1	.1	.....	.....	.1	.....	.4	.....	.2
Burns by hot metal	6.9	12.0	6.9	5.1	.6	.8	2.2	.8	4.5
Burns by gas	.4	.5	.1	.1	.....	.4	.9	.1	.3
Burns by electricity	.2	.2	.1	.1	.1	.....	.8	.....	.2
Burns by steam and water	1.3	.9	.4	.1	.9	.7	2.2	.3	.8
Burns not specified	12.5	8.1	9.4	2.7	2.5	3.0	7.0	7.9	6.5
Hernia	.2	.....	.3	.2	.2	.5	.2	.2	.2
Plural injuries	1.3	1.7	1.6	1.3	2.3	2.5	1.3	1.4	1.7
Unclassified	6.7	7.8	7.3	2.3	6.3	7.1	6.5	10.6	6.5
Not reported	.1	.3	.1	.1	.3	.....	.....	.7	.2
Total temporary disabilities	98.8	98.2	97.8	98.0	97.7	96.6	96.7	97.9	97.8
Total nonfatal injuries	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

APPENDIX D.—NATURE OF INJURY, BY DEPARTMENTS, IN 1 ESTABLISHMENT EMPLOYING AVERAGE OF 6,624 MEN, 6 YEARS ENDING DEC. 31, 1910.

NUMBER OF INJURIES.

Nature of injury.	Blast furnaces.	Steel works.	Rolling mills.	Foundries.	Yards.	Mechanical.	Miscellaneous.	Total.
PERMANENT INJURIES.								
Loss of one arm	.....	1	.....	.....	.....	.....	.....	1
Loss of one leg	2	1	.....	1	2	1	.....	7
Loss of thumb	2	2	3	.....	.....	.....	.....	7
Loss of first finger	2	.....	4	1	.....	1	.....	8
Loss of other fingers	6	3	12	3	4	3	.....	31
Loss of one foot	1	1	.....	.....	1	.....	.....	3
Loss of one eye	.....	3	1	1	.....	4	.....	9
Loss of both eyes	.....	1	.....	.....	.....	.....	.....	1
Total permanent injuries	13	12	20	6	7	9	.....	67
TEMPORARY DISABILITIES.								
Other eye injuries	91	46	47	25	31	85	19	344
Fracture of one arm	14	14	12	1	5	5	5	56
Fracture of both arms	1	.....	.....	.....	.....	.....	2	3
Fracture of one leg	18	14	36	6	11	12	5	102
Fracture of both legs	.....	.....	.....	.....	.....	.....	2	2
Fracture of ribs	5	5	3	.....	2	6	1	22
Other fractures	12	12	20	5	5	10	3	67
Hand crushed or broken	4	7	8	3	4	7	3	36
Foot or toes crushed or broken	22	31	64	5	30	20	6	178
Fingers crushed or broken	41	52	128	31	54	34	16	356
Hand or fingers bruised, cut, etc	205	220	394	66	197	224	40	1,346
Foot or toes bruised, cut, etc	215	181	387	56	180	157	27	1,203
Other bruises, etc	364	280	429	75	240	231	87	1,706
Dislocations	76	86	99	16	68	95	22	462
Punctured wounds	35	19	46	11	20	39	10	180
Asphyxia	56	8	4	.....	3	11	8	90
Burns by hot metal	192	290	11	38	3	10	.....	544
Burns by gas	41	37	12	3	.....	6	2	101
Burns by electricity	12	7	36	2	1	10	29	97
Burns by steam and water	51	9	8	3	7	18	2	98
Burns not specified	201	73	87	15	15	32	.....	423
Hernia	1	4	2	2	1	3	1	14
Plural injuries	30	20	18	6	7	8	8	97
Unclassified	4	4	3	.....	2	1	2	16
Not reported	.....	3	1	1	.....	.....	14	19
Total temporary disabilities	1,691	1,422	1,855	370	886	1,024	314	7,562
Total nonfatal injuries	1,704	1,434	1,875	376	893	1,033	314	7,629

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APPENDIX D.—NATURE OF INJURY, BY DEPARTMENTS, IN 1 ESTABLISHMENT EMPLOYING AVERAGE OF 6,624 MEN, 6 YEARS ENDING DEC. 31, 1910—Concluded.

PER CENT OF INJURIES OF EACH NATURE.

Nature of injury.	Blast furnaces.	Steel works.	Rolling mills.	Foundries.	Yards.	Mechanical.	Miscellaneous.	Total.
Total permanent injuries	0.8	0.8	1.1	1.6	0.8	0.9	.....	0.9
TEMPORARY DISABILITIES.								
Eye injuries	5.3	3.2	2.5	6.6	3.5	3.2	6.1	4.5
Fracture of one arm	.8	1.0	.6	.3	.6	.5	1.6	.7
Fracture of both arms	.1	.....	.....	.....	.....	.....	.6	.....
Fracture of one leg	1.1	1.0	1.9	1.6	1.2	1.2	1.6	1.3
Fracture of both legs	.....	.....	.....	.....	.....	.....	.6	.....
Fracture of ribs	.3	.3	.2	.....	.2	.6	.3	.3
Other fractures	.7	.8	1.1	1.3	.6	1.0	1.0	.9
Hand crushed or broken	.2	.5	.4	2.1	.6	.7	1.0	.5
Foot or toes crushed or broken	1.3	2.2	3.4	1.3	3.4	1.9	1.9	2.3
Fingers crushed or broken	2.4	3.6	6.8	8.2	6.0	3.3	5.1	4.7
Hand or fingers bruised, cut, etc	12.0	15.3	21.0	17.6	23.0	21.7	12.8	17.6
Foot or toes bruised, cut, etc	12.6	12.6	20.6	14.9	20.1	15.2	8.6	15.8
Other bruises, cuts, etc	21.4	19.5	22.9	19.9	26.8	22.3	27.9	22.4
Dislocations	4.5	6.0	5.3	4.3	7.6	9.2	7.1	5.9
Punctured wounds	2.1	1.3	2.5	2.9	2.2	3.8	3.2	2.4
Asphyxia	3.3	.6	.2	.....	.3	1.1	2.6	1.2
Burns by hot metal	11.3	20.2	.6	10.1	.3	1.0	.....	7.2
Burns by gas	2.4	2.6	.6	.8	.....	.6	.6	1.3
Burns by electricity	.7	.5	1.9	.5	.1	1.0	9.3	1.3
Burns by steam and water	3.0	.6	.4	.8	.8	1.7	.6	1.3
Burns not specified	11.8	5.1	4.6	4.0	1.7	3.2	.....	5.5
Hernia	.1	.3	.1	.5	.1	.3	.3	.2
Plural injuries	1.8	1.4	1.0	1.6	.3	.3	2.6	1.3
Unclassified	.2	.3	.2	.....	.2	.1	.6	.2
Not reported	.....	.2	.1	.3	.....	.....	4.5	.2
Total temporary disabilities	99.2	99.2	98.9	98.4	99.2	89.1	100.0	99.1
Total nonfatal injuries	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

APPENDIX E.—NUMBER AND PER CENT OF INJURED IN PLANT INVESTIGATED WHO RETURNED TO WORK IN SPECIFIED WEEK, BY DEPARTMENTS AND YEARS, 1905 TO 1910.

BLAST FURNACES.

NUMBER.

Years.	Total injured persons.	Injured persons who returned to work in specified week.														
		1st.	2d.	3d.	4th.	5th.	6th.	7th.	8th.	9th.	10th.	11th.	12th.	13th.	14th and later.	Not reported.
1905	406	195	70	37	28	23	9	3	5	5	3	.....	.....	4	2	22
1906	399	146	80	48	26	30	12	7	6	16	1	3	.....	2	3	19
1907	314	108	54	43	17	14	12	3	3	10	5	5	2	5	16	17
1908	191	72	37	15	16	6	9	4	7	3	1	3	1	.....	12	5
1909	213	105	28	21	12	10	8	4	2	1	1	.....	2	.....	6	13
1910	181	78	32	18	16	14	3	1	1	4	2	.....	1	3	5	3
Total	1,704	704	301	182	115	97	53	22	24	39	13	11	6	14	44	79

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APPENDIX E.—NUMBER AND PER CENT OF INJURED IN PLANT INVESTIGATED WHO RETURNED TO WORK IN SPECIFIED WEEK, BY DEPARTMENTS AND YEARS, 1905 TO 1910—Continued.

BLAST FURNACES—Concluded.

PER CENT.

Years.	Total injured persons.	Injured persons who returned to work in specified week.														
		1st.	2d.	3d.	4th.	5th.	6th.	7th.	8th.	9th.	10th.	11th.	12th.	13th.	14th and later.	Not reported.
1905.....	100.0	48.0	17.2	9.1	6.9	6.0	2.2	0.7	1.2	1.2	0.7	.....	.....	1.0	0.5	5.4
1906.....	100.0	36.6	20.1	12.0	6.5	7.5	3.0	1.8	1.5	4.0	.3	0.8	.....	.5	.8	4.8
1907.....	100.0	34.4	17.2	13.7	5.4	4.5	3.8	1.0	1.0	3.2	1.6	1.6	0.6	1.6	5.1	5.4
1908.....	100.0	37.7	19.4	7.9	3.4	3.1	4.7	2.1	3.7	1.6	.5	1.6	.5	.....	6.3	2.6
1909.....	100.0	49.3	13.1	9.9	5.6	4.7	3.8	1.9	.9	.5	.5	.....	.9	.....	2.8	6.1
1910.....	100.0	43.1	17.7	9.9	3.8	7.7	1.7	.6	.6	2.2	1.1	.....	.6	1.7	2.8	1.6
Total.	100.0	41.3	17.7	10.7	6.7	5.7	3.1	1.3	1.4	2.3	.8	.6	.4	.8	2.6	4.7

STEEL WORKS.

NUMBER.

1905.....	267	120	52	27	22	15	3	5	4	1	2	1	1	1	4	9
1906.....	271	80	42	34	25	19	7	6	3	10	2	.....	.....	4	11	23
1907.....	335	106	60	42	33	19	10	11	5	7	3	3	.....	3	11	22
1908.....	119	47	25	14	11	5	4	4	1	1	3	.....	.....	.....	2	2
1909.....	225	74	42	24	24	10	6	10	3	3	5	.....	3	1	9	11
1910.....	217	77	35	29	24	10	10	4	5	3	2	1	.....	1	11	5
Total.	1,434	504	256	170	139	78	40	40	21	25	17	5	4	10	48	77

PER CENT.

1905.....	100.0	44.9	19.5	10.1	8.2	5.6	1.1	1.9	1.5	0.4	0.7	0.4	0.4	0.4	1.5	3.4
1906.....	100.0	29.5	15.5	12.5	9.2	7.0	2.6	2.2	1.1	3.7	.7	.....	.....	1.5	4.1	10.3
1907.....	100.0	31.6	17.9	12.5	9.9	5.7	3.0	3.3	1.5	2.1	.9	.9	.....	.9	3.3	6.6
1908.....	100.0	39.5	21.0	11.8	9.2	4.2	3.4	3.4	.8	.8	2.5	.....	.....	.....	1.7	1.7
1909.....	100.0	32.9	18.7	10.7	10.7	4.4	2.7	4.4	1.3	1.3	2.2	.....	1.3	.4	4.0	4.9
1910.....	100.0	35.5	16.1	13.4	11.1	4.6	4.6	1.8	2.3	1.4	.9	.4	.....	.4	5.1	2.3
Total.	100.0	35.1	17.9	11.9	9.7	5.4	2.8	2.8	1.5	1.7	1.2	.3	.3	.7	3.3	5.4

ROLLING MILLS.

NUMBER.

1905.....	348	164	80	29	18	17	9	6	2	1	4	1	.....	2	1	14
1906.....	401	149	66	40	25	34	12	7	10	8	3	2	1	2	10	32
1907.....	357	124	74	39	13	20	20	8	6	7	1	2	3	2	13	25
1908.....	168	67	29	14	14	9	6	3	5	4	1	.....	1	2	7	6
1909.....	309	129	39	29	30	22	11	6	7	7	6	.....	.....	1	5	17
1910.....	293	100	68	35	24	22	13	2	5	4	2	3	.....	.....	5	10
Total.	1,876	733	356	186	124	124	71	32	35	31	17	8	5	9	41	104

PER CENT.

1905.....	100.0	47.1	23.0	8.3	5.2	5.0	2.6	1.7	0.6	0.3	1.2	0.3	.....	0.6	0.3	3.9
1906.....	100.0	37.2	16.5	10.0	6.2	8.5	3.0	1.7	2.5	2.0	.7	.5	0.2	.5	2.5	8.0
1907.....	100.0	34.7	20.7	10.9	3.6	5.6	5.6	2.2	1.7	2.0	.3	.6	.8	.6	3.6	7.0
1908.....	100.0	39.9	17.3	8.3	8.3	5.4	3.6	1.8	3.0	2.4	.6	.....	.6	1.2	4.2	3.6
1909.....	100.0	41.7	12.6	9.4	9.7	7.1	3.6	1.9	2.3	2.3	1.9	.....	.....	.3	1.6	5.5
1910.....	100.0	34.1	23.2	11.9	8.2	7.5	4.4	.7	1.7	1.4	.7	1.0	.....	.....	1.7	3.4
Total.	100.0	39.1	19.0	9.9	6.6	6.6	3.8	1.7	1.9	1.7	.9	.4	.3	.3	2.2	5.5

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APPENDIX E.—NUMBER AND PER CENT OF INJURED IN PLANT INVESTIGATED WHO RETURNED TO WORK IN SPECIFIED WEEK, BY DEPARTMENTS AND YEARS, 1905 TO 1910—Continued.

MECHANICAL.

NUMBER.

Years.	Total injured persons.	Injured persons who returned to work in specified week.														
		1st.	2d.	3d.	4th.	5th.	6th.	7th.	8th.	9th.	10th.	11th.	12th.	13th.	14th and later.	Not reported.
1905	415	248	64	32	17	14	8	.....	7	6	1	1	.....	2	5	10
1906	186	88	38	20	6	9	5	2	3	3	2	.....	2	.....	1	7
1907	182	86	32	18	9	3	5	3	4	1	1	2	2	5	3	8
1908	73	31	12	8	4	4	1	2	1	2	.....	1	1	1	4	1
1909	76	34	13	3	5	2	4	1	3	3	.....	.....	1	1	2	4
1910	102	48	21	11	7	3	2	2	.....	2	.....	.....	.....	.....	4	2
Total.	1,034	535	180	92	48	35	25	10	18	17	4	4	6	9	19	32

PER CENT.

1905	100.0	59.8	15.4	7.7	4.1	3.4	1.9	.....	1.7	1.4	0.2	0.2	.....	0.5	1.2	2.4
1906	100.0	47.3	20.4	10.8	3.2	4.8	2.7	1.1	1.6	1.6	1.1	.....	1.1	.....	.5	3.8
1907	100.0	47.3	17.6	9.9	4.9	1.6	2.7	1.6	2.2	.5	.5	1.1	1.1	2.7	1.6	4.4
1908	100.0	42.5	16.4	11.0	5.5	5.5	1.4	2.7	1.4	2.7	.....	1.4	1.4	1.4	5.5	1.4
1909	100.0	44.8	17.1	3.9	6.6	2.6	5.3	1.3	3.9	3.9	.....	.....	1.3	1.3	2.6	5.3
1910	100.0	47.1	20.6	10.8	6.9	2.9	2.0	2.0	.....	2.0	.....	.....	.....	.....	3.9	2.0
Total.	100.0	51.7	17.4	8.9	4.6	3.4	2.4	1.0	1.5	1.6	.4	.4	.6	.9	1.8	3.1

YARDS.

NUMBER.

1905	290	168	41	20	15	11	6	11	1	1	2	1	.....	1	3	9
1906	199	73	35	20	12	20	6	3	2	2	2	.....	2	2	7	13
1907	146	47	24	14	11	12	8	1	4	1	2	.....	2	1	4	15
1908	60	24	10	9	5	4	1	2	.....	.....	2	.....	.....	.....	.....	3
1909	94	35	20	9	6	4	2	2	3	2	.....	2	.....	1	1	7
1910	105	46	14	15	8	4	3	3	1	4	1	.....	3	.....	1	2
Total.	894	393	144	87	57	55	26	22	11	10	9	3	7	5	16	49

PER CENT.

1905	100.0	57.9	14.1	6.9	5.2	3.8	2.1	3.8	0.3	0.3	0.7	0.3	.....	0.3	1.0	3.1
1906	100.0	36.7	17.6	10.1	6.0	10.1	3.0	1.5	1.0	1.0	1.0	.....	1.0	1.0	3.4	6.5
1907	100.0	32.2	16.4	9.6	7.5	8.2	5.5	.7	2.7	.7	1.4	.....	1.4	.7	2.7	10.3
1908	100.0	40.0	16.7	15.0	8.3	6.7	1.7	3.3	.....	.....	3.3	.....	.....	.....	.....	5.0
1909	100.0	37.2	21.3	9.6	6.4	4.3	2.1	2.1	3.2	2.1	.....	2.1	.....	1.1	1.1	7.4
1910	100.0	43.8	13.3	14.3	7.6	3.8	2.9	2.9	1.0	3.8	1.0	.....	2.9	.....	1.0	1.9
Total.	100.0	44.0	16.1	9.7	6.4	6.2	2.9	2.5	1.2	1.1	1.0	.3	.8	.6	1.8	5.5

MISCELLANEOUS DEPARTMENTS.[1]

NUMBER.

1905	176	94	29	13	12	11	3	.....	3	2	.....	.....	.....	.....	4	5
1906	111	36	25	10	10	2	6	4	.....	3	1	2	.....	3	1	8
1907	75	29	7	11	5	4	3	.....	.....	1	.....	2	.....	.....	7	6
1908	62	30	8	5	5	3	4	2	.....	.....	.....	.....	1	.....	3	1
1909	153	64	25	15	10	6	7	1	6	4	2	.....	1	.....	3	9
1910	110	33	22	20	10	9	4	1	2	.....	.....	1	.....	1	5	2
Total.	687	286	116	74	52	35	27	8	11	10	3	5	2	4	23	31

[1] Including foundry, docks and ore yards, electrical, and other departments.

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APPENDIX E.—NUMBER AND PER CENT OF INJURED IN PLANT INVESTIGATED WHO RETURNED TO WORK IN SPECIFIED WEEK, BY DEPARTMENTS AND YEARS, 1905 TO 1910—Concluded.

MISCELLANEOUS DEPARTMENTS—Concluded.

PER CENT.

Years.	Total injured persons.	Injured persons who returned to work in specified week.														
		1st.	2d.	3d.	4th.	5th.	6th.	7th.	8th.	9th.	10th.	11th.	12th.	13th.	14th and later.	Not reported.
1905	100.0	53.4	16.5	7.4	6.8	6.3	1.7	.....	1.7	1.1	.....	.....	.....	.....	2.3	2.8
1906	100.0	32.4	22.5	9.0	9.0	1.8	5.4	3.6	.....	2.7	0.9	1.8	.....	2.7	.9	7.2
1907	100.0	38.7	9.3	14.7	6.7	5.3	4.0	.....	.....	1.3	.....	2.7	.....	.....	9.3	8.0
1908	100.0	48.4	12.9	8.1	8.1	4.8	6.5	3.2	.....	.....	.....	.....	1.6	.....	4.8	1.6
1909	100.0	41.8	16.3	9.8	6.5	3.9	4.6	.7	3.9	2.6	1.3	.....	.7	.....	2.0	5.9
1910	100.0	30.0	20.0	18.2	9.1	8.2	3.6	.9	1.8	.....	.....	.9	.....	.9	4.5	1.8
Total.	100.0	41.6	16.9	10.8	7.6	5.1	3.9	1.2	1.6	1.5	.4	.7	.3	.6	3.3	4.5

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APPENDIX F.—NUMBER OF INJURED IN PLANT INVESTIGATED WHO OCCUPATIONS, FOR

BLAST FURNACES.

Occupations.	Injured persons who returned to work in specified week.							
	1st.	2d.	3d.	4th.	5th.	6th.	7th.	8th.
Bar and clay men	1	1						
Blacksmiths and helpers	3	2				1		
Blowers		2						
Boiler cleaners	1	1						
Boiler makers and helpers	3		1		2			
Bottom fillers	32	24	6	7	7		3	1
Bricklayers and helpers	15	3			2			
Cagers		1						
Carpenters	3	4	3			1		
Carpenters' helpers								
Cinder snappers	26	9	9	4	8	4		
Crane hookers	1		1	2				
Cranemen	4	3	1	1				
Drillers	1							
Drop men		1						
Dust men	3		2	2	1	2	1	
Dynamiters					1			
Electrical helpers	1		1					
Engineers, blowing	1							
Firemen	6			1		1	1	1
Foreman	20	9	8	2	2	2	2	1
Greasers							1	
Handy men and helpers	12	9	4	3	2			
Hoist operators	1							
Keepers	24	13	6	9	2	2	1	2
Keepers' helpers	50	25	21	11	3	4	3	1
Laborers	316	122	80	51	41	23	4	11
Ladle inspectors					1			
Ladle men	2	2	1		1			
Machinists and helpers	7	4	3			1		1
Master mechanics								
Motor inspectors		1						
Oilers	10	6	4	2	4	1	1	1
Ore-bridge operators			1					
Painters	6		2	3				
Pig-machine men	1	1						
Pipe fitters and helpers	23	15	4	2	4	3	1	2
Pump men	2							
Riggers	52	17	10	7	6	5	1	
Roofers	5	3						
Roofers' helpers					1			
Scale-car operators	4		2	1				
Scrap men				1			1	
Skip-hoist operators			1					
Stockers	3							
Stove cleaners	7	4	3	4	2			
Stove tenders	24	14	2		3	2	1	
Stove tenders' helpers	1	1						
Structural-iron workers					1			
Switchmen	1		1					
Top fillers	5		1		1		1	1
Water tenders	1							
Unclassified	17	4	4	2	2	1		2
Total	704	301	182	115	97	53	22	24

BESSEMER STEEL WORKS.

Blacksmiths		1						
Bottom-house men		2		1			1	
Bottom makers	3	1	1					
Chippers	2							
Crane hookers	2	3	3	1	1			
Cranemen	3	1	1					
Cupola chargers	4	1	1		1	1		
Cupola liners and helpers		2						
Dynamite blasters								
Engineers, blowing	1	1						
Engineers, locomotive					1			
Firemen	1							

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RETURNED TO WORK IN SPECIFIED WEEK, BY DEPARTMENTS AND 6-YEAR PERIOD, 1905 TO 1910.

BLAST FURNACES.

Injured persons who returned to work in specified week.								Days lost.		Fatal injuries.	Total injuries.
9th.	10th.	11th.	12th.	13th.	14th and later.	Week not reported.	Total.	Total.	Average per injury for which days lost were reported.		
.....	.....	.....	.....	.....	1	.....	3	115	38	.....	3
.....	.....	.....	.....	.....	1	.....	7	174	25	.....	7
.....	.....	.....	.....	.....	.....	1	3	21	11	.....	3
1	.....	.....	.....	.....	1	1	5	186	47	.....	5
.....	.....	1	.....	.....	3	.....	10	599	60	.....	10
1	1	.....	.....	.....	1	3	86	1,350	16	.....	86
.....	.....	.....	.....	.....	2	2	24	387	18	.....	24
.....	.....	.....	.....	.....	.....	.....	1	9	9	.....	1
.....	.....	.....	.....	.....	.....	.....	11	144	13	.....	11
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1
2	1	.....	.....	1	1	5	70	1,518	24	2	72
.....	.....	.....	.....	.....	.....	.....	4	79	20	.....	4
.....	.....	.....	1	.....	.....	.....	10	169	17	1	11
.....	.....	.....	.....	.....	.....	.....	1	1	1	.....	1
.....	.....	.....	.....	.....	.....	.....	1	9	9	.....	1
1	.....	.....	.....	.....	.....	1	13	313	26	.....	13
.....	.....	.....	.....	.....	.....	.....	1	30	30	.....	1
.....	.....	.....	.....	.....	.....	.....	2	24	12	.....	2
.....	.....	.....	.....	.....	1	.....	2	142	71	.....	2
.....	.....	.....	.....	.....	.....	1	11	187	19	1	12
.....	.....	.....	1	.....	3	.....	50	1,252	25	2	52
.....	.....	.....	.....	.....	.....	.....	1	45	45	.....	1
.....	.....	.....	.....	.....	2	3	35	584	18	1	36
.....	.....	.....	.....	.....	.....	.....	1	6	6	.....	1
1	.....	1	.....	.....	.....	3	64	996	16	2	66
4	2	3	1	3	2	5	147	2,915	21	4	151
17	5	5	1	7	14	41	738	12,874	18	15	753
.....	.....	.....	.....	.....	.....	.....	1	35	35	.....	1
.....	.....	.....	.....	.....	1	.....	7	196	28	.....	7
.....	.....	.....	1	.....	.....	1	18	307	18	.....	18
.....	.....	.....	.....	.....	.....	1	1	.....	.....	.....	1
.....	.....	.....	.....	.....	.....	.....	1	14	14	.....	1
1	.....	.....	.....	.....	.....	.....	30	563	19	3	33
.....	.....	.....	.....	.....	.....	.....	1	17	17	.....	1
1	.....	.....	.....	.....	.....	1	13	197	16	.....	13
.....	.....	.....	.....	.....	.....	.....	2	11	6	.....	2
2	1	.....	.....	.....	1	2	60	1,053	18	1	61
.....	.....	.....	.....	.....	.....	.....	2	4	2	.....	2
3	3	.....	.....	1	4	3	112	2,268	21	4	116
.....	.....	.....	.....	.....	.....	1	9	78	10	.....	9
.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	1
.....	.....	.....	.....	.....	.....	.....	7	68	10	3	10
.....	.....	1	.....	.....	.....	1	4	144	48	.....	4
.....	.....	.....	.....	.....	.....	.....	1	21	21	.....	1
.....	.....	.....	.....	.....	.....	.....	3	12	4	.....	3
.....	.....	.....	.....	.....	2	1	23	717	33	4	27
.....	.....	.....	1	1	.....	.....	48	675	14	1	49
.....	.....	.....	.....	.....	.....	.....	2	15	8	.....	2
.....	.....	.....	.....	.....	.....	.....	1	31	31	.....	1
.....	.....	.....	.....	.....	.....	1	3	26	13	.....	3
4	.....	.....	.....	1	.....	1	15	488	35	.....	15
.....	.....	.....	.....	.....	1	.....	2	117	59	.....	2
.....	.....	.....	.....	.....	3	.....	36	1,281	37	.....	36
39	13	11	6	14	44	79	1,704	32,467	20	45	1,749

BESSEMER STEEL WORKS.

.....	.....	.....	.....	.....	.....	.....	1	11	11	.....	1
.....	.....	.....	.....	.....	.....	.....	4	90	23	.....	4
.....	.....	.....	.....	.....	.....	.....	5	44	9	.....	5
.....	.....	.....	.....	.....	1	1	4	173	58	.....	4
1	.....	.....	.....	.....	.....	.....	11	206	19	2	13
.....	.....	.....	.....	.....	.....	.....	5	40	8	.....	5
.....	1	.....	.....	.....	.....	1	10	181	20	.....	10
.....	.....	.....	.....	.....	.....	1	3	33	17	.....	3
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1
.....	.....	.....	.....	.....	.....	.....	2	13	7	.....	2
.....	.....	.....	.....	.....	.....	.....	1	32	32	.....	1
.....	.....	.....	.....	.....	.....	.....	1	3	3	1	2

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APPENDIX F.—NUMBER OF INJURED IN PLANT INVESTIGATED WHO OCCUPATIONS, FOR 6-YEAR

BESSEMER STEEL WORKS—Concluded.

Occupations.	Injured persons who returned to work in specified week.							
	1st.	2d.	3d.	4th.	5th.	6th.	7th.	8th.
Foremen	3		1	1				
Gas makers	1							
Greasers	1							
Handy men	1	1		1				1
Laborers	123	52	39	26	22	12	10	4
Ladle liners		1						
Ladle men	7	5	3	5	2	1	2	1
Machinists	1							
Machinists' helpers	2							
Melters	2	1		1				
Melters' helpers	3	1	2	1				
Millwrights' helpers								1
Mixer operators	2							
Mold cappers								
Mold cleaners								
Oilers				1				
Pitmen				1				
Repair men	1			2				
Riggers	1		1					
Roofers		1						
Runner men	4	1						
Scrappers	4	3		3	1			
Steel pourers	3	6	2	1	1			
Steel pourers' helpers							1	
Stockers	2	1	1			3		
Stopper makers								
Switchmen	2	1	1	1	1			
Tappers' helpers		1						
Vessel liners	1	1						
Vessel men	5	6	3	1	1			1
Weighers	1				1			
Unclassified	5	3	2				1	
Not reported		1	1					
Total	191	98	62	47	32	17	15	8

OPEN-HEARTH STEEL WORKS.

Blacksmiths and helpers	1							
Boiler makers' helpers		1						
Bricklayers	9	3	3	1	2		1	
Bricklayers' helpers				1				
Carmen					1			
Carpenters			1					
Charging-machine operators		1						
Cinder men				2				
Crane hookers	1		2	1		1		
Cranemen	5	2	1	2	1	1		
Door operators	2	1			1	1		
Drillers								
Drop men	2		1					
Electricians	3							
Firemen	16	9	5	5	2			1
Foremen	6	3			2		1	
Gas makers		1						
Handy men	4	2				1		1
Helpers	1		1					
Laborers	103	53	29	31	8	7	10	2
Ladle liners	1							
Ladle men	36	20	20	9	13	4	3	4
Machinists and helpers	6	1	2	1		1		
Melters	1	2			1			
Melters' helpers	73	37	19	27	9	3	4	2
Mold cleaners			1					
Oilers								
Pipe fitters and helpers	1		2					
Pitmen	19	7	9	6	5	2	4	1
Riggers	1		1					
Scrappers	1							
Stage men								

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RETURNED TO WORK IN SPECIFIED WEEK, BY DEPARTMENTS AND PERIOD, 1905 TO 1910—Continued.

BESSEMER STEEL WORKS—Concluded.

Injured persons who returned to work in specified week.								Days lost.		Fatal injuries.	Total injuries.
9th.	10th.	11th.	12th.	13th.	14th and later.	Week not reported.	Total.	Total.	Average per injury for which days lost were reported.		
.....	.....	.....	.....	.....	.....	.....	5	55	11	1	6
.....	.....	.....	.....	.....	.....	.....	1	3	3	.....	1
.....	.....	.....	.....	.....	.....	.....	1	3	3	.....	1
.....	.....	.....	.....	.....	.....	.....	4	93	23	1	5
10	5	3	2	1	9	26	344	6,887	22	5	349
.....	.....	.....	.....	.....	.....	.....	1	12	12	.....	1
2	.....	.....	.....	.....	1	3	32	781	27	.....	32
.....	.....	.....	.....	.....	.....	.....	1	2	2	.....	1
.....	.....	.....	.....	.....	.....	.....	2	7	4	.....	2
.....	.....	.....	.....	.....	.....	.....	4	44	11	.....	4
.....	.....	.....	.....	.....	.....	.....	7	86	12	.....	7
.....	.....	.....	.....	.....	.....	.....	1	55	55	.....	1
.....	.....	.....	.....	.....	.....	.....	2	12	6	.....	2
.....	.....	.....	.....	.....	1	.....	1	160	160	.....	1
.....	.....	.....	.....	.....	1	.....	1	150	150	.....	1
.....	.....	.....	.....	.....	.....	.....	1	27	27	.....	1
.....	.....	.....	.....	.....	.....	.....	1	27	27	.....	1
.....	.....	.....	.....	.....	.....	.....	3	54	18	.....	3
.....	.....	.....	1	.....	.....	.....	3	101	34	.....	3
.....	.....	.....	.....	.....	.....	.....	1	13	13	.....	1
.....	.....	.....	.....	.....	.....	1	6	25	5	.....	6
.....	1	.....	.....	.....	.....	1	13	313	24	1	14
.....	.....	.....	.....	.....	.....	1	14	159	12	.....	14
.....	.....	.....	.....	.....	.....	1	2	47	47	.....	2
.....	.....	.....	.....	.....	1	.....	8	389	49	1	9
.....	.....	.....	.....	.....	1	.....	1	120	120	.....	1
.....	.....	.....	.....	1	.....	.....	7	178	25	.....	7
.....	.....	.....	.....	.....	.....	.....	1	13	13	.....	1
.....	.....	.....	.....	.....	.....	.....	2	18	9	.....	2
.....	.....	.....	.....	.....	2	.....	19	244	13	2	21
.....	.....	.....	.....	.....	.....	.....	2	39	20	.....	2
.....	1	.....	.....	1	.....	2	15	295	23	.....	15
.....	.....	.....	.....	.....	.....	.....	2	22	11	.....	2
13	8	3	3	3	17	38	555	11,254	22	15	570

OPEN-HEARTH STEEL WORKS.

.....	.....	.....	.....	.....	.....	.....	1	2	2	.....	1
.....	.....	.....	.....	.....	.....	.....	1	13	13	.....	1
.....	2	.....	.....	.....	.....	.....	21	379	18	.....	21
.....	.....	.....	.....	.....	.....	.....	1	25	25	.....	1
.....	.....	.....	.....	.....	.....	.....	1	32	32	.....	1
.....	.....	.....	.....	.....	.....	.....	1	20	20	.....	1
.....	.....	.....	.....	.....	.....	.....	1	13	13	.....	1
.....	.....	.....	.....	.....	.....	.....	2	48	24	.....	2
1	.....	.....	.....	1	2	.....	9	559	62	1	10
.....	.....	.....	1	.....	.....	2	15	265	20	1	16
.....	.....	.....	.....	.....	1	.....	6	320	53	.....	6
.....	.....	.....	.....	1	.....	.....	1	90	90	.....	1
.....	.....	.....	.....	.....	.....	.....	3	25	9	.....	3
.....	.....	.....	.....	.....	.....	.....	3	10	3	.....	3
1	.....	.....	.....	.....	1	2	42	668	16	.....	42
.....	.....	.....	.....	1	1	.....	14	363	26	.....	14
.....	.....	.....	.....	.....	.....	.....	1	8	8	.....	1
.....	.....	.....	.....	.....	1	.....	9	237	26	.....	9
.....	.....	.....	.....	.....	.....	1	3	20	10	.....	3
5	.....	1	.....	1	9	18	277	5,570	22	.....	277
.....	.....	.....	.....	.....	.....	.....	1	2	2	.....	1
2	1	.....	.....	.....	6	6	124	2,814	24	1	125
.....	.....	.....	.....	.....	1	1	13	241	20	.....	13
1	.....	.....	.....	.....	.....	.....	5	119	24	.....	5
1	2	.....	.....	1	5	4	187	3,720	20	.....	187
.....	.....	.....	.....	.....	.....	.....	1	17	17	.....	1
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	1
.....	1	1	.....	2	2	1	3	35	12	.....	3
.....	.....	.....	.....	.....	.....	.....	63	1,682	27	.....	63
.....	.....	.....	.....	.....	.....	.....	2	23	12	1	3
.....	.....	.....	.....	.....	.....	.....	1	5	5	.....	1
.....	1	.....	.....	.....	.....	.....	1	67	67	.....	1

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APPENDIX F.—NUMBER OF INJURED IN PLANT INVESTIGATED WHO OCCUPATIONS, FOR 6-YEAR

OPEN-HEARTH STEEL WORKS—Concluded.

Occupations.	Injured persons who returned to work in specified week.							
	1st.	2d.	3d.	4th.	5th.	6th.	7th.	8th.
Steel pourers		2						
Stockers	10	7	8	2	1	2	2	1
Stopper makers		1	1					
Stopper setters	1							
Switchmen	1	1						
Weighers	1	1						
Unclassified	8	3	2	1				1
Total	313	158	108	92	46	23	25	13

BLOOMING MILLS.

Blacksmiths	1							
Bottom makers	1					1		
Bricklayers	1							
Carmen			1					
Chippers	4	1	2		1	1		
Cinder men	1							
Crane hookers	3	2	1		1			
Cranemen	2	1						
Door operators	1							
Drillers	1					1		
Drillers' helpers								
Electricians	2				1			
Engineers, roll		1						
Firemen	1							
Foremen	2		1			1		
Handy men		2	1					
Heaters and helpers	1							
Ingot-buggy operators	2	2		1	1			
Laborers	23	7	9	1	6	4	1	
Lever men	1							
Loaders		1	1		1			
Machinists	1	1	1		1			1
Machinists' helpers		1		2	1			
Manipulators	1							
Millwrights					1			
Motor inspectors		1						
Oilers and greasers	2	1			1			
Painters						1		
Pipe fitters	1	1		1				
Pipe fitters' helpers				1				
Repair men		1				1		
Riggers	3	1	1					
Rollers	1							
Roll hands								
Shearmen	2					1		
Shearmen's helpers	1							
Stampers			1					
Table men	2	1						
Weighers	1							
Unclassified	5	2	2	1				
Total	67	28	21	7	15	11	1	1

SLABBING MILL.

Chippers	7			2	2		1	
Cinder men	1							
Crane hookers	4	5		1	1			
Cranemen	1			1	2			
Electricians	1							
Engineers, roll								
Firemen	4	3		1				
Foremen	2	2		1				
Handy men	1							
Heaters	1							
Heaters' helpers	1							

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RETURNED TO WORK IN SPECIFIED WEEK, BY DEPARTMENTS AND PERIOD, 1905 TO 1910—Continued.

OPEN-HEARTH STEEL WORKS—Concluded.

Injured persons who returned to work in specified week.								Days lost.			
9th.	10th.	11th.	12th.	13th.	14th and later.	Week not reported.	Total.	Total.	Average per injury for which days lost were reported.	Fatal injuries.	Total injuries.
1							3	84	28		3
	2				2	1	38	825	23		38
							2	23	12		2
							1	2	2		1
							2	15	8		2
							2	15	8		2
						3	18	197	13		18
12	9	2	1	7	31	39	879	18,553	22	5	884

BLOOMING MILLS.

							1	7	7		1
							2	46	23		2
							1	2	2		1
							1	21	21		1
				1			10	208	21		10
							1	7	7		1
		1				1	9	168	21		9
					1		4	177	44		4
							1	2	2		1
							2	43	22		2
										1	1
							3	39	13		3
							1	8	8		1
							1	2	2		1
							4	68	17		4
						1	4	45	15		4
							1	6	6		1
							6	93	16		6
1					2	3	57	1,051	19	3	60
						1	2	2	2		2
							3	58	19		3
1							6	175	29		6
							5	110	22		54
							1	1	1		1
							1	30	30		1
					1		2	182	91		2
						1	5	46	12		5
							1	40	40		1
							3	42	14		3
							1	22	22		1
							2	47	24		2
							5	47	9		5
							1	4	4		1
						1	1				1
							3	43	14		3
							1	2	2		1
							1	16	16		1
							3	18	6		3
							1	5	5		1
						1	11	203	18		11
2		1		1	4	9	168	3,086	19	4	172

SLABBING MILL.

							12	188	16		12
							1	4	4		1
1					1		13	335	26		13
							4	90	23		4
							1	7	7		1
						1	1				1
							8	69	9		8
							5	56	11		5
							1	4	4		1
							1	2	2		1
							1	7	7		1

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APPENDIX F.—NUMBER OF INJURED IN PLANT INVESTIGATED WHO OCCUPATIONS, FOR 6-YEAR

PLATE MILLS—Concluded.

Occupations.	Injured persons who returned to work in specified week.							
	1st.	2d.	3d.	4th.	5th.	6th.	7th.	8th.
Machinists	2	1	1					
Machinists' helpers	4	1						
Markers	2	1						
Oilers and greasers			1	1				
Painters	1		1					
Pipe fitters	1							
Pipe fitters' helpers		1						
Riggers	3	2	2					1
Rollers	1							
Roll turners	1							
Scrap men	1			1				
Shearmen	8	3	1	1		1		1
Shearmen's helpers	5	4	2	1				
Straighteners		1						
Table men	2				1	1		
Unclassified	4	2	1	1		1		
Total	171	99	44	29	22	13	6	7

MECHANICAL.

Blacksmiths	19	10	2					1
Blacksmiths' helpers	16	6	4	2	1	1	1	
Boiler makers	9	2		1				
Boiler makers' helpers		2	2					
Bricklayers	19	14	5				1	1
Bricklayers' helpers	24	10	4	4	1	2		1
Carpenters	17	4	3	1			2	2
Carpenters' helpers	2							
Chippers	1							
Crane hookers		4	2					
Cranemen	10	4	1	2	3	1		
Drillers	8	1	1					
Engineers	4		1	1	1			
Engineers, locomotive	19	8	3	2		1	1	
Engineers, mechanical	2	3		1				
Firemen	6	2	2	1		1		1
Foremen	6	2	1		1	2		
Hammermen's helpers	4	2						
Handy men	28	12	5	3	3	1		
Heaters								
Hoisters	1		1					
Inspectors	1							1
Laborers	60	10	13	4	6	4	1	1
Lathe hands	1							
Machine hands	3	1					1	
Machinists	81	18	11	7	4	4		2
Machinists' helpers	59	22	9	8	4	3		1
Oilers and greasers	9	4	3	2				1
Painters	1	2	1			1	1	
Pattern makers	1	1						
Pipe coverers	1							
Pipe fitters	12	7	3	1	3	1		
Pipe fitters' helpers	13	2	1		1	1		1
Punch-press operators			1					
Repair men	3		1		1			
Riggers	49	14	7	6	3	2	2	4
Riveters	2							
Riveters' helpers		1						
Roll chippers	1							
Roll turners	1		1		1			
Roofers	14	5	2					
Roofers' helpers	3				1			
Shearmen	1	1						
Straighteners' helpers (gaggers)	1							
Structural-iron workers	7	1	1	1	1			1
Unclassified	16	5	1	1				
Total	535	180	92	48	35	25	10	18

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RETURNED TO WORK IN SPECIFIED WEEK, BY DEPARTMENTS AND PERIOD, 1905 TO 1910—Continued.

PLATE MILLS—Concluded.

Injured persons who returned to work in specified week.								Days lost.		Fatal injuries.	Total injuries.
9th.	10th.	11th.	12th.	13th.	14th and later.	Week not reported.	Total.	Total.	Average per injury for which days lost were reported.		
.....	.....	.....	.....	.....	1	1	6	189	40	1	7
.....	.....	.....	.....	.....	.....	1	6	86	14	.....	6
.....	.....	.....	.....	.....	.....	.....	3	15	5	.....	3
.....	.....	.....	.....	.....	.....	.....	2	44	22	.....	2
.....	.....	.....	.....	.....	.....	.....	2	20	10	.....	2
.....	.....	.....	.....	.....	.....	.....	1	2	2	.....	1
.....	.....	.....	.....	.....	.....	.....	1	9	9	.....	1
.....	.....	.....	.....	.....	.....	.....	8	112	14	.....	8
.....	.....	.....	.....	.....	.....	.....	1	4	4	.....	1
.....	.....	.....	.....	.....	.....	.....	1	2	2	.....	1
.....	.....	.....	.....	.....	.....	.....	2	28	14	.....	2
.....	.....	.....	.....	.....	.....	1	16	199	13	1	17
1	.....	.....	.....	.....	.....	.....	13	186	14	.....	13
.....	.....	.....	.....	.....	.....	.....	1	10	10	.....	1
.....	.....	.....	.....	.....	.....	.....	4	76	19	.....	4
1	1	.....	.....	.....	.....	1	12	242	22	1	13
5	3	.....	.....	2	7	30	438	6,805	17	4	442

MECHANICAL.

2	.....	.....	.....	.....	1	1	36	506	14	.....	36
1	1	.....	.....	.....	2	2	37	713	20	.....	37
.....	.....	.....	.....	2	1	.....	15	367	20	.....	15
.....	.....	.....	.....	.....	.....	.....	4	54	14	.....	4
.....	.....	.....	.....	.....	.....	2	42	400	10	.....	42
1	.....	.....	.....	.....	.....	3	50	596	13	1	51
.....	1	.....	.....	.....	.....	2	32	443	15	.....	32
.....	.....	.....	.....	.....	.....	.....	2	9	5	.....	2
.....	.....	.....	.....	.....	.....	.....	1	5	5	.....	1
.....	.....	.....	.....	.....	.....	1	7	85	15	.....	7
.....	.....	.....	.....	.....	.....	.....	21	269	12	.....	21
.....	.....	.....	.....	.....	.....	.....	10	58	6	.....	10
.....	.....	.....	.....	.....	.....	.....	7	84	12	.....	7
1	.....	.....	.....	.....	1	1	37	536	15	1	38
.....	.....	.....	.....	.....	.....	1	7	65	11	.....	7
.....	.....	1	.....	.....	.....	.....	14	264	19	.....	14
.....	.....	.....	.....	1	.....	.....	13	253	19	.....	13
.....	.....	.....	.....	.....	.....	.....	6	43	7	.....	6
1	.....	1	.....	.....	.....	.....	54	667	12	1	55
.....	.....	.....	.....	.....	.....	1	1	.....	.....	.....	1
.....	.....	.....	.....	.....	.....	.....	2	26	13	.....	2
.....	.....	.....	.....	.....	.....	.....	2	54	27	.....	2
1	1	.....	2	.....	.....	2	105	1,372	13	2	107
.....	.....	.....	.....	.....	.....	.....	1	5	5	.....	1
.....	.....	.....	.....	.....	.....	.....	5	71	14	.....	5
1	1	.....	1	.....	5	2	137	2,045	15	2	139
1	.....	1	1	2	2	5	118	1,880	17	2	120
1	.....	.....	.....	.....	2	.....	22	684	31	.....	22
1	.....	.....	.....	.....	.....	.....	7	191	27	1	8
.....	.....	.....	.....	.....	.....	.....	2	12	6	.....	2
.....	.....	.....	.....	.....	.....	.....	1	4	4	.....	1
.....	.....	1	.....	1	.....	.....	29	467	16	.....	29
.....	.....	.....	.....	.....	.....	1	20	215	11	.....	20
1	.....	.....	.....	.....	.....	.....	2	77	39	.....	2
.....	.....	.....	.....	.....	.....	1	6	69	14	1	7
2	.....	.....	1	3	5	4	102	2,178	22	2	104
.....	.....	.....	.....	.....	.....	.....	2	8	4	.....	2
.....	.....	.....	.....	.....	.....	1	2	10	10	.....	2
.....	.....	.....	.....	.....	.....	.....	1	2	2	.....	1
.....	.....	.....	.....	.....	.....	.....	3	62	21	.....	3
.....	.....	.....	.....	.....	.....	.....	21	142	7	.....	21
1	.....	.....	.....	.....	.....	.....	5	98	20	.....	5
.....	.....	.....	.....	.....	.....	.....	2	14	7	.....	2
.....	.....	.....	.....	.....	.....	.....	1	5	5	.....	1
1	.....	.....	.....	.....	.....	1	14	226	17	1	15
1	.....	.....	1	.....	.....	1	26	305	12	.....	26
17	4	4	6	9	19	32	1,034	15,639	16	14	1,048

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APPENDIX F.—NUMBER OF INJURED IN PLANT INVESTIGATED WHO OCCUPATIONS, FOR 6-YEAR

FOUNDRY.

Occupations.	Injured persons who returned to work in specified week.							
	1st.	2d.	3d.	4th.	5th.	6th.	7th.	8th.
Blacksmiths' helpers	1							
Carpenters			1			1		
Carpenters' helpers	1							
Chargers								
Chippers	15	6	3	4	2	2	1	
Core makers	5	2						
Crane hookers	7	2	7	3	3	3	1	2
Cranemen	8	2	1	1	2	2		
Cupola chargers	1						1	
Electricians	2							
Firemen	1							
Gas makers		2						
Handy men	3	1			2			
Heaters				1				
Laborers	55	21	13	9	5	7	2	3
Ladle liners	1							
Ladle men	2		1		1			
Ladle men's helpers			1					
Machinists	1							
Machinists' helpers	1							
Molders	29	17	2	8	6	4	1	1
Molders' helpers	11	6	5	4	2		1	
Motor inspectors	1							
Roll turners	1							
Saw men	1							
Stockers		1						
Timekeepers				1				
Unclassified		1	1					
Total	147	61	35	31	23	19	7	6

DOCKS AND ORE YARDS.

Crane hookers	1	1	2		1			
Foremen								
Handy men	1		1					
Hoisters	1		2					
Laborers	13	7	4	6	5	1	1	2
Machinists			1					
Motor inspectors	1							
Oilers	1		1			1		
Ore-bridge operators	2	1						
Riggers	2	3	1	2				
Samplers								
Scoopers	6	1	2	3	1			
Total	28	13	14	11	7	2	1	2

YARD DEPARTMENT.

Bricklayers	1							
Carpenters	4	2						
Carpenters' helpers							1	
Chippers	2							
Crane hookers	6		1	1	2	2		
Cranemen	2							
Cranemen, locomotive		1	1					
Drop men	4	4	2	1			1	
Electricians	1							
Engineers, locomotive	3		1				1	
Engineers, locomotive crane	1							
Foremen	5	7	2	1	3			
Greasers							1	
Handy men								
Laborers	268	91	59	42	35	11	13	7
Linemen			1					
Loaders	1	2	1					

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RETURNED TO WORK IN SPECIFIED WEEK, BY DEPARTMENTS AND PERIOD, 1905 TO 1910—Continued.

FOUNDRY.

Injured persons who returned to work in specified week.								Days lost.			
9th.	10th.	11th.	12th.	13th.	14th and later.	Week not reported.	Total.	Total.	Average per injury for which days lost were reported.	Fatal injuries.	Total injuries.
.....	.....	.....	.....	.....	.....	.....	1	4	4	.....	1
.....	.....	.....	.....	.....	.....	.....	2	58	29	.....	2
.....	.....	.....	.....	.....	.....	.....	1	5	5	.....	1
.....	.....	1	.....	.....	.....	.....	1	74	74	.....	1
1	.....	1	.....	.....	.....	1	36	589	17	.....	36
1	.....	.....	.....	.....	1	1	10	458	51	.....	10
1	1	.....	.....	.....	2	2	34	1,355	42	.....	34
.....	.....	.....	.....	.....	1	.....	17	348	20	.....	17
.....	.....	.....	.....	.....	.....	.....	2	51	26	.....	2
.....	.....	.....	.....	.....	.....	.....	2	9	5	.....	2
.....	.....	.....	.....	1	.....	.....	2	87	44	.....	2
.....	.....	.....	.....	.....	.....	.....	2	23	12	.....	2
.....	.....	.....	.....	.....	.....	.....	6	80	13	.....	6
.....	.....	.....	.....	.....	.....	.....	1	28	28	.....	1
1	1	1	1	1	8	9	137	3,207	25	2	139
.....	.....	.....	.....	.....	.....	.....	1	2	2	.....	1
.....	.....	.....	.....	.....	.....	.....	4	62	16	.....	4
.....	.....	.....	.....	.....	.....	.....	1	15	15	.....	1
.....	.....	.....	.....	.....	1	.....	2	115	58	.....	2
.....	.....	.....	.....	.....	.....	.....	1	1	1	.....	1
1	1	1	1	.....	2	2	76	1,574	21	.....	76
1	.....	.....	.....	.....	.....	.....	30	472	16	.....	30
.....	.....	.....	.....	.....	.....	.....	1	7	7	.....	1
.....	.....	.....	.....	.....	.....	.....	1	5	5	.....	1
.....	.....	.....	.....	.....	.....	.....	1	5	5	.....	1
.....	.....	.....	.....	.....	.....	.....	1	10	10	.....	1
.....	.....	.....	.....	.....	.....	.....	1	27	27	.....	1
.....	.....	.....	.....	.....	.....	.....	2	27	14	.....	2
6	3	4	2	2	15	15	376	8,698	24	2	378

DOCKS AND ORE YARDS.

.....	.....	.....	.....	.....	.....	1	6	76	15	.....	6
.....	.....	.....	.....	.....	.....	1	1	.....	.....	.....	1
.....	.....	.....	.....	.....	.....	.....	2	25	13	.....	2
.....	.....	.....	.....	.....	.....	.....	3	38	13	.....	3
2	.....	.....	.....	.....	1	1	43	880	21	.....	43
.....	.....	.....	.....	.....	.....	.....	1	15	15	.....	1
.....	.....	.....	.....	.....	.....	.....	1	6	6	.....	1
.....	.....	.....	.....	1	.....	1	5	149	37	.....	5
.....	.....	.....	.....	.....	.....	.....	3	16	5	1	4
.....	.....	.....	.....	.....	.....	.....	8	105	13	1	9
.....	.....	.....	.....	.....	.....	1	1	.....	.....	.....	1
.....	.....	1	.....	.....	1	2	17	475	30	.....	17
2	.....	1	.....	1	2	7	91	1,785	21	2	93

YARD DEPARTMENT.

.....	.....	.....	.....	.....	.....	.....	1	2	2	.....	1
.....	.....	.....	.....	.....	.....	.....	6	31	5	.....	6
.....	.....	.....	.....	.....	.....	.....	1	48	48	.....	1
.....	.....	.....	.....	1	.....	.....	3	95	32	.....	3
.....	.....	.....	.....	.....	.....	.....	12	221	18	.....	12
.....	.....	.....	.....	.....	.....	.....	2	8	4	.....	2
.....	.....	.....	.....	.....	.....	.....	2	28	14	.....	2
.....	.....	.....	1	.....	.....	1	14	237	18	.....	14
.....	.....	.....	.....	.....	.....	.....	1	3	3	.....	1
.....	.....	.....	.....	.....	.....	.....	5	66	13	.....	5
.....	.....	.....	.....	.....	.....	.....	1	6	6	.....	1
.....	.....	.....	.....	.....	.....	2	20	244	14	.....	20
.....	.....	.....	.....	.....	.....	.....	1	44	44	.....	1
.....	.....	.....	.....	.....	.....	1	1	.....	.....	.....	1
5	7	2	4	3	11	33	591	9,675	17	9	600
.....	.....	.....	.....	.....	.....	.....	1	20	20	.....	1
1	.....	.....	.....	.....	.....	.....	5	101	20	.....	5

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APPENDIX F.—NUMBER OF INJURED IN PLANT INVESTIGATED WHO OCCUPATIONS, FOR 6-YEAR

YARD DEPARTMENT—Concluded.

Occupations.	Injured persons who returned to work in specified week.							
	1st.	2d.	3d.	4th.	5th.	6th.	7th.	8th.
Pipe fitters' helpers	1							
Riveters' helpers	1							
Scrap men					1			
Shearmen			1	2				1
Shearmen's helpers	1				1			
Stockers	6	1						
Switchmen	83	36	17	9	13	12	5	3
Trackmen								
Weighmasters	1							
Yardmasters	1			1				
Yard superintendents						1		
Unclassified	1		1					
Total	393	144	87	57	55	26	22	11

ELECTRICAL DEPARTMENT.

Electricians	31	7	3		1			
Electricians' apprentices			1					
Electricians' helpers	7	8	2			1		1
Engineers, electrical	2							
Firemen	1					1		
Foremen	1	2	1					
Handy men	1		1					
Laborers	1	2	1	1				
Lamp trimmers	1							
Linemen	8	4	4	1	2			
Linemen's helpers			1					
Machine hand				1				
Machinists	1	2						
Motor inspectors	3							
Motor men	1							
Oilers	3			1				
Repair men		1	1					
Riggers	2							
Unclassified	8	4	1	1	1	1		1
Total	71	25	16	5	4	3		2

MISCELLANEOUS DEPARTMENTS.

Chemists	2							
Chemists' helpers	1					1		
Clerks	1		1					
Firemen	1	1						
Handy men								
Inspectors								
Laborers	15	7	6	3	1			1
Machinists		1						
Oilers		1						
Pipe fitters' helpers				1				
Samplers	1	1						
Timekeepers	2	1	2					
Watchmen	4	2		1		1		
Unclassified	13	3						
Total	40	17	9	5	1	2		1

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RETURNED TO WORK IN SPECIFIED WEEK, BY DEPARTMENTS AND PERIOD, 1905 TO 1910—Concluded.

YARD DEPARTMENT—Concluded.

Injured persons who returned to work in specified week.								Days lost.			
9th.	10th.	11th.	12th.	13th.	14th and later.	Week not reported.	Total.	Total.	Average per injury for which days lost were reported.	Fatal injuries.	Total injuries.
.....	.....	.....	.....	.....	.....	.....	1	6	6	.....	1
.....	.....	.....	.....	.....	.....	.....	1	6	6	.....	1
.....	.....	.....	.....	.....	.....	.....	1	30	30	.....	1
1	.....	.....	.....	.....	.....	.....	5	187	37	.....	5
.....	.....	.....	.....	.....	.....	.....	2	41	20	.....	2
.....	.....	.....	.....	.....	.....	1	8	28	4	.....	8
3	2	1	2	1	5	10	202	4,001	21	1	203
.....	.....	.....	.....	.....	.....	1	1	.....	.....	.....	1
.....	.....	.....	.....	.....	.....	.....	1	4	4	.....	1
.....	.....	.....	.....	.....	.....	.....	2	25	13	.....	2
.....	.....	.....	.....	.....	.....	.....	1	40	40	.....	1
.....	.....	.....	.....	.....	.....	.....	2	20	10	.....	2
10	9	3	7	5	16	49	894	15,217	18	10	904

ELECTRICAL DEPARTMENT.

.....	.....	.....	.....	.....	.....	.....	42	263	6	3	45
.....	.....	.....	.....	.....	.....	.....	1	15	15	.....	1
1	.....	.....	.....	.....	.....	.....	15	241	16	.....	15
.....	.....	.....	.....	.....	.....	.....	2	7	4	.....	2
.....	.....	.....	.....	.....	.....	.....	2	44	22	.....	2
.....	.....	.....	.....	.....	.....	.....	4	41	10	.....	4
.....	.....	.....	.....	.....	.....	.....	2	28	14	.....	2
.....	.....	.....	.....	.....	.....	.....	5	71	14	.....	5
.....	.....	.....	.....	.....	.....	.....	1	3	3	.....	1
.....	.....	.....	.....	.....	1	.....	20	340	18	1	21
.....	.....	.....	.....	.....	.....	.....	1	18	18	.....	1
.....	.....	.....	.....	.....	.....	.....	1	25	25	.....	1
.....	.....	.....	.....	.....	.....	.....	3	19	6	.....	3
.....	.....	.....	.....	.....	.....	.....	3	16	5	.....	3
.....	.....	.....	.....	.....	.....	.....	1	2	2	.....	1
.....	.....	.....	.....	.....	1	3	8	765	153	.....	8
.....	.....	.....	.....	.....	.....	.....	2	26	13	.....	2
.....	.....	.....	.....	.....	.....	.....	2	9	5	2	4
.....	.....	.....	.....	.....	.....	.....	17	233	14	.....	17
1	.....	.....	.....	.....	2	3	132	2,166	17	6	138

MISCELLANEOUS DEPARTMENTS.

.....	.....	.....	.....	.....	.....	.....	2	11	6	.....	2
.....	.....	.....	.....	.....	.....	.....	2	40	20	.....	2
.....	.....	.....	.....	.....	.....	.....	2	18	9	.....	2
.....	.....	.....	.....	.....	.....	.....	2	18	9	.....	2
.....	.....	.....	.....	1	.....	.....	1	90	90	.....	1
.....	.....	.....	.....	.....	1	.....	1	94	94	.....	1
1	.....	.....	.....	.....	1	4	39	699	19	.....	39
.....	.....	.....	.....	.....	.....	.....	1	14	14	.....	1
.....	.....	.....	.....	.....	.....	.....	1	10	10	.....	1
.....	.....	.....	.....	.....	.....	.....	1	22	22	.....	1
.....	.....	.....	.....	.....	.....	1	3	18	9	.....	3
.....	.....	.....	.....	.....	.....	1	6	52	10	.....	6
.....	.....	.....	.....	.....	.....	.....	8	99	12	.....	8
.....	.....	.....	.....	.....	2	1	19	374	21	.....	19
1	.....	.....	.....	1	4	7	88	1,559	19	.....	88

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APPENDIX G.—DIRECT CAUSES OF INJURIES IN PLANT INVESTIGATED, TO 1910—

RAIL MILL—Concluded.

Occupations.	Number of injuries caused by—											
	Asphyxiating gas.	Burning gas.	Exploding gas.	Hot metal explosions and spills.	Furnace break outs.	Electricity.	Hot water and steam.	Nails, splinters, etc.	Furnace slips.	Belts, gears, etc.	Cranes.	Locomotives, cars, etc.
Roll hands												
Roll turners												
Saw men												
Shearmen												
Stampers				1								
Straighteners								1				
Straighteners' helpers												
Straighteners' helpers (gaggers)												
Switchmen											2	
Table men				1								
Unclassified												1
Total		1		9		6	3	5		5	54	9

STRUCTURAL MILLS.

Babbitt men												
Blacksmiths												
Carpenters' helpers												
Chargers												
Chippers												
Crane hookers											20	
Cranemen						7				1		
Drillers						1						
Electricians												
Engineers, locomotive												
Engineers, roll												
Foremen											1	
Gaugers												
Guide setters												
Greasers												
Handy men												
Hotbed men												
Inspectors												1
Laborers				2				1		3	32	4
Lever men						1					1	
Loaders											3	
Machinists						1						
Machinists' helpers				1				1		1	2	
Manipulators												
Markers						1						
Millwrights												
Motor inspectors						1						
Motor men												
Oilers						1						1
Repair men												
Riggers						1				1	5	
Rollers and helpers											1	1
Roll hands												
Roll turners												
Roll turners' helpers										1		
Saw men											1	
Shearmen												
Shearmen's helpers												
Shippers												1
Stampers						1						
Straighteners										1		
Straighteners' helpers (gaggers)												
Structural-iron workers												
Table men						1						
Unclassified						1						
Total				3		17		2		8	66	8

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BY DEPARTMENTS AND OCCUPATIONS, FOR SIX-YEAR PERIOD, 1905 1910.

BLAST FURNACES.

Number of injuries caused by—															
Switches.	Flying scale.	Falling and flying objects.	Metal in usual motion.	Metal in unusual motion.	Handling stock.	Lifting weights.	Handling material in process.	Piling, loading, etc.	Using tools.	Operating machines	Falls.	Yard conditions.	Unclassified.	Not reported.	Total injuries.
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
.....	.....	3	.....	.....	1	.....	.....	.....	1	1	.....	.....	.....	.....	7
.....	.....	1	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	3
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
.....	2	1	.....	.....	1	.....	.....	.....	.....	1	1	1	.....	.....	10
.....	2	29	.....	.....	41	.....	.....	.....	.....	.....	3	.....	3	.....	86
.....	1	10	.....	.....	2	.....	.....	.....	1	.....	5	.....	1	1	24
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	1
.....	.....	3	.....	.....	1	1	.....	.....	1	.....	3	.....	.....	.....	12
.....	1	7	.....	.....	1	.....	.....	.....	2	.....	5	.....	2	2	72
.....	.....	1	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	4
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3	.....	.....	.....	11
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2
.....	.....	1	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	2
.....	1	1	.....	.....	1	.....	.....	.....	.....	.....	2	.....	2	.....	12
.....	1	10	1	.....	.....	.....	.....	.....	4	1	6	4	.....	.....	52
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
.....	2	11	.....	.....	.....	1	.....	1	4	2	7	.....	1	.....	36
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
.....	5	10	.....	.....	.....	.....	.....	.....	4	2	1	.....	.....	1	66
.....	7	20	.....	.....	3	1	.....	.....	10	13	12	.....	3	8	151
.....	29	213	1	.....	56	1	3	.....	39	12	67	7	10	34	753
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	1
.....	.....	2	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	7
.....	.....	8	.....	.....	1	.....	.....	.....	1	3	3	.....	.....	.....	18
.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	1
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	13	9	1	1	.....	33
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	1
.....	2	2	.....	.....	2	.....	.....	.....	.....	.....	5	.....	.....	.....	13
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	2
.....	3	5	.....	.....	2	.....	.....	.....	5	1	9	1	2	2	61
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	2
.....	5	36	.....	.....	7	1	1	.....	3	6	13	1	3	4	116
.....	2	1	.....	.....	.....	.....	.....	.....	.....	1	3	.....	.....	.....	10
.....	1	5	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	10
.....	.....	3	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....	4
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	1	.....	3
.....	.....	9	.....	.....	.....	1	.....	.....	1	.....	2	.....	1	.....	27
.....	2	9	.....	.....	1	.....	.....	.....	1	5	6	1	.....	.....	51
.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	[a] 1
.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
.....	1	1	.....	.....	1	.....	.....	.....	.....	3	.....	.....	.....	.....	15
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	1	2
.....	3	1	.....	.....	1	.....	.....	.....	.....	1	6	.....	.....	.....	36
.....	72	408	2	.....	123	6	4	1	80	69	178	16	30	53	1,749

BESSEMER STEEL WORKS.

.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1	.....	.....	1	.....	4
.....	.....	3	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	5
.....	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4
.....	.....	2	.....	.....	1	.....	.....	.....	.....	.....	1	.....	.....	.....	13
.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	1	5
.....	.....	3	.....	.....	1	1	.....	.....	.....	.....	1	.....	.....	.....	10
.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	2
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	1	2
.....	1	2	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	6

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APPENDIX H.—PROVISIONS FOR IMMEDIATE CARE OF INJURED AND FOR HOSPITAL SERVICE IN 530 IRON AND STEEL ESTABLISHMENTS REPORTING.

[The statements in this table are in the exact form submitted by the companies.]

Plant number.	Number of employees.	Provision for immediate aid.	Further treatment.			Who bears expense of treatment?
			Is hospital used?	If hospital is used.		
				Is it owned by company?	Distance from plant.	
1	207	Local physician, under agreement with employees, visits establishment an hour or two daily and responds to calls.	Yes..	No...	2 miles.....	Employees, by regular fees.
2	21	Doctor called.....	Yes..	No...	9 miles.....	Insurance Co.
3	19	.....do.....	Yes..	No...	.....do.....	Do.
4	36	Pillows, splints, and articles used for "first aid to injured."	Yes..	No...	1 block.....	Not reported.
5	38	Medical attendance summoned immediately.	No...	.....	.....	The company.
6	320	Equipped for first aid; assistance and ambulance called when necessary.	Yes..	No...	2 miles.....	Hospital, to which company makes regular contributions.
7	189	Red Cross emergency cabinet.....	No...	.....	.....	Ins. Co. first treatment; employee balance.
8	2,447	Equipped for first aid; assistance and ambulance called when needed.	Yes..	No...	1½ miles.....	Hospital, to which company is large contributor.
9	(1)	Emergency hospital room.....	Yes..	No...	½ mile.....	Company.
10	(1)	Emergency hospital at works.....	Yes..	(1)...	(1).....	Do.
11	39	Equipped for first aid.....	No...	.....	.....	Not reported.
12	378	Emergency medical cabinet in office.	No...	.....	.....	Ins. Co. for first aid.
13	223	Send for the works' surgeon.....	Yes..	No...	3 miles.....	Company.
14	955	First-aid outfit.....	Yes..	No...	10 miles.....	Company usually.
15	150	Local doctor called.....	Yes..	No...	6 miles.....	Ins. Co. and Furnace Co.
16	360	First-aid outfit.....	Yes..	No...	½ mile.....	Company.
17	636	Company employs surgeon.....	Yes..	No...	3 miles.....	Ins. Co. for first treatment.
18	116	Small emergency outfit in laboratory; doctor is called.	No...	.....	.....	Insurance Co.
19	229	Doctor is called and, if necessary, an ambulance.	Yes..	No...	Under ½ mile.	Company.
20	48	No accidents have occurred.....	.....	.....	.....	
21	207	Full medical aid and hospital expenses.	Yes..	No...	9 miles.....	Do.
22	567	Reserved room; first-aid department.	Yes..	No...	1 mile.....	Company; covered by insurance.
23	511	None.....	No...	.....	.....	
24	100	First aid; doctor near.....	Yes..	No...	3 miles.....	Employees' Ins. Co.
25	1,103	Completely appointed hospital room; doctor on call at all times.	Yes..	No...	12 miles.....	Company for first aid; Ins. Co., further treatment.
26	455	Taken to office and given such care as we best know; then sent to hospital.	Yes..	No...	4 miles.....	Company for first treatment.
27	590	Hospital supplies for first aid.....	Yes..	No...	5 miles.....	Insurance Co.
28	50	First aid and local doctor.....	Yes..	No...	1½ miles.....	Company.
29	90	Sent to hospital.....	Yes..	No...	1 mile.....	Varies between company and patient.
30	109	None.....	Yes..	No...	1½ miles.....	Insurance Co.
31	55	First-aid appliances.....	Yes..	No...	1 mile.....	Hospital.
32	101	First aid to injured outfit; 3 doctors within call.	Yes..	No...	18 miles.....	Company, as a rule.
33	191	Employees sustaining slight injury sent to local doctor; seriously injured sent to hospital.	Yes..	No...	1 mile.....	Company maintains a bed in hospital.
34	196	None.....	Yes..	No...	15 miles.....	Company.
35	239	First-aid cabinet; physicians located near by.	Yes..	No...	7 miles.....	Do.
36	29	Company furnishes medical assistance.	Yes..	No...	3 miles.....	No fixed policy.
37	187	First aid to injured; doctor called...	Yes..	No...	6 miles.....	Liability Co.
38	63	Service of doctors residing in vicinity.	Yes..	No...	3 miles.....	Company, if in fault.
39	122	Emergency hospital in charge of man qualified as "first aid to the injured."	Yes..	Yes..	In plant.....	Company.

[1] Not reported.

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APPENDIX H.—PROVISIONS FOR IMMEDIATE CARE OF INJURED AND FOR HOSPITAL SERVICE IN 530 IRON AND STEEL ESTABLISHMENTS REPORTING—Continued.

Plant number.	Number of employees.	Provision for immediate aid.	Further treatment.			Who bears expense of treatment?
			Is hospital used?	If hospital is used.		
				Is it owned by company?	Distance from plant.	
40	197	Slightly injured employees go to doctor; in more serious injuries doctor is called.	No...	.....	.....	
41	144	Have a supply of phenol, sodique, and bandages.	Yes..	No...	3½ blocks....	Hospital.
42	255	No provision.....	Yes..	No...	(1).....	Regular contributions to both hospitals.
43	115	Company exercises judgment about caring for injured employees.	Yes..	No...	½ mile.....	Hospital.
44	133	First aid to injured located in office..	Yes..	No...	4 blocks.....	By yearly subscription.
45	169	Give first aid.....	Yes..	No...	5 blocks.....	Annual donations by company.
46	124	Have supply of emergency remedies, bandages, etc.	Yes..	No...	1 mile.....	Patient or hospital; company makes yearly contributions.
47	93	Local physician.....	Yes..	No...	3 miles.....	Depends on conditions of accident.
48	101	Have a few remedies to allay pain from burns, etc.	No...	No...	.....	Have had no accident requiring treatment.
49	437	Equipped with first aid to injured cases; injured employees immediately taken to a physician.	Yes..	No...	9 miles.....	Company contributes to maintenance of hospital.
50	61	Never had any accidents.....	No...	.....	.....	
51	163	None.....	No...	.....	.....	
52	153	Local physician.....	Yes..	No...	12 miles.....	Company.
53	261	Red Cross first aid in laboratory.....	Yes..	No...	1½ miles.....	Company contributes yearly to hospital.
54	295	Physician's first aid.....	Yes..	No...	1 mile.....	Company contributes to hospital.
55	225	Red Cross medical box, first aid to injured.	Yes..	No...	8 miles.....	Hospital.
56	824	First-aid service rendered at works and physician called when necessary.	Yes..	No...	7 blocks.....	Free treatment; company contributes to hospital fund.
57	495	Emergency room equipped with first-aid requisites and experienced attendant.	Yes..	No...	1½ miles.....	Hospital.
58	144	Accidents very rare.....	Yes..	No...	3½ miles.....	Employees.
59	274	Special room with stretcher and cot; antiseptic bandages; antiseptic baths.	Yes..	No...	2 miles.....	Company contributes annually to hospital.
60	154	Telephone local physician.....	Yes..	No...	4 miles.....	Free treatment.
61	175	Doctor called.....	Yes..	No...	1 mile.....	Company, at hospital.
62	269	Near-by physician called for first aid.	Yes..	No...	¾ mile.....	First aid, indemnity company; balance by injured person.
63	57	Send for doctor.....	Yes..	No...	6 miles.....	Insurance company.
64	321	Furnish doctor.....	Yes..	No...	1 mile.....	Company.
65	61	Phenol, sodique, cotton, and bandages are kept on hand.	Yes..	No...	9 blocks.....	Do.
66	569	Nearest physician called or injured employee taken to physician's office.	Yes..	No...	6 miles.....	First treatment, company; hospital treatment, injured person.
67	739	Sent to hospital.....	Yes..	No...	10 blocks....	Company makes yearly donation to hospital.
68	435	Regularly employed physician.....	Yes..	No...	1 mile.....	Company.
69	19	Doctor's care.....	No...	.....	.....	Have had no accidents.
70	194	Foremen trained to give first aid...	No...	.....	.....	
71	108	At office and then doctor.....	No...	.....	.....	If slight, company; severe, insurance company.
72	33	Sent to home and physician called..	Yes..	.....	10 miles.....	Company.
73	349	3 first-aid cabinets are maintained throughout the plant.	Yes..	No...	1 mile.....	State.
74	180	Doctor's services.....	Yes..	No...	4 miles.....	Insurance company.
75	70	Given medical attention.....	Yes..	No...	1½ miles.....	Employee.
76	344	Emergency hospital in laboratory...	Yes..	No...	½ mile.....	Company.

[1] Two hospitals, distant ½ mile and 1 mile, respectively.

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APPENDIX H.—PROVISIONS FOR IMMEDIATE CARE OF INJURED AND FOR HOSPITAL SERVICE IN 530 IRON AND STEEL ESTABLISHMENTS REPORTING—Continued.

Plant number.	Number of employees.	Provision for immediate aid.	Further treatment.			Who bears expense of treatment?
			Is hospital used?	If hospital is used.		
				Is it owned by company?	Distance from plant.	
77	369	Bandages and ointment for burns are kept.	Yes..	No...	1 mile.....	Company makes annual subscriptions to hospital.
78	132	Taken to hospital.....	Yes..	No...	6 blocks.....	Company.
79	60	First aid to injured outfit.....	Yes..	No...	1 mile.....	Charity.
80	215	First aid.....	Yes..	No...	½ mile.....	Company.
81	107	Doctor called; patient taken to his home.	No...	.....	.....	(1).
82	97	Office attendants, with accident-cabinet materials.	Yes..	No...	¼ mile.....	Company; hospital when taken there.
83	102					
84	9	None.....	(1)...	(1)...	(1).....	(1).
85	145	Emergency accident cabinets.....	Yes..	No...	5 blocks.....	Company contributes to hospitals.
86	284	Call surgeon located near plant.....	Yes..	No...	¾ mile.....	Free; company subscribes annually to hospital.
87	7	Have had no accidents.....	.....	.....	.....	
88	1,924	Emergency hospital in plant.....	Yes..	No...	1 mile.....	Company.
89	1,051	Emergency station at mill.....	Yes..	No...	1½ miles.....	Do.
90	712	Medicine chest in office; physician called to administer first aid.	Yes..	No...	1 mile.....	Relief association.
91	46	Place in hands of physician or surgeon.	Yes..	No...	.....do.....	Liability Insurance Co. for first aid and occasionally subsequent treatment.
92	679	First-aid appliances are kept; physician called.	Yes..	No...	10 miles.....	Company.
93	532	Full line of first-aid supplies on hand.	Yes..	No...	1 mile.....	Company through insurance company.
94	438	First aid at works.....	Yes..	No...	2 miles.....	Company.
95	1,637	First aid in office; doctor called when necessary.	Yes..	No...	½ mile.....	Do.
96	(1)	Call for hospital ambulance and nearest physician.	Yes..	No...	9 blocks.....	Do
97	796	Hospital room equipped with all first aid to injured in separate building.	Yes..	No...	.....	Do.
98	257	First aid on premises by employees or doctor as needed.	Yes..	No...	10 to 15 minutes.	Company and insurance jointly.
99	1,062	First-aid necessaries; 8 doctors within 5 minutes' drive.	Yes..	No...	7 miles.....	Company.
100	332	Doctor called.....	Yes..	No...	½ mile.....	Do.
101	551	Treatment administered in company's office; doctor called in serious cases.	Yes..	No...	6 blocks.....	Do.
102	41	Company pays for first aid.....	No...	.....	.....	
103	637	Doctor called to render first aid.....	Yes..	No...	45 minutes..	For first aid, company.
104	855	Taken to office and doctor called....	Yes..	No...	1 mile.....	Company.
105	134	Doctor called.....	Yes..	No...	3 miles.....	Do.
106	307	Bandages, ointments, dressings, etc., kept on hand; company surgeon called.	Yes..	No...	10 miles.....	Do.
107	82	Doctor called.....	Yes..	No...	3 miles.....	Do.
108	196	First aid by company's surgeon.....	Yes..	No...	5 miles.....	Do.
109	127	Have first-aid cabinet, etc.....	Yes..	No...	¾ mile.....	Depends on circumstances.
110	580	Emergency hospital.....	Yes..	No...	1½ miles.....	Company.
111	273	First aid applied in company's laboratory.	Yes..	No...	3 miles.....	Do.
112	58	Physician called.....	Yes..	No...	1 mile.....	Have not yet had a case.
113	121	Bandages, etc., kept at plant; physician called immediately.	Yes..	No...	22 miles.....	Employees, by regular payments.
114	240	Physician called.....	Yes..	No...	4 miles.....	Company.
115	100	Employees' homes are near by; 4 physicians within quick response.	No...	.....	.....	Do.
116	184	Doctor on the location.....	Yes..	Yes..	Close by....	Company and employees.

[1] Not reported.

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APPENDIX H.—PROVISIONS FOR IMMEDIATE CARE OF INJURED AND FOR HOSPITAL SERVICE IN 530 IRON AND STEEL ESTABLISHMENTS REPORTING—Continued.

Plant number.	Number of employees.	Provision for immediate aid.	Further treatment.			Who bears expense of treatment?
			Is hospital used?	If hospital is used.		
				Is it owned by company?	Distance from plant.	
117	147	First-aid remedies in charge of chemist.	Yes..	No...	½ mile.....	Company.
118	141	Call nearest physician.....	Yes..	No...	A few miles.	Do.
119	327	Injured are sent to their homes or to hospital.	Yes..	No...	2 blocks.....	Themselves mostly.
120	99	First-aid outfit; services of any physician we can get at time of accident.	Yes..	No...	23 miles.....	Insurance company.
121	31	Regular mill medicine case	Yes..	No...	1 mile.....	Company.
122	60	Bandages and first-aid outfit.....	Yes..	No...	1½ miles.....	Insurance company.
123	31	Call doctor.....	Yes..	No...	½ mile.....	Never had a hospital bill.
124	614	Doctor called, or injured is taken to his office.	Yes..	No...	2 miles.....	Company.
125	362	Fully equipped medicine cabinet...	Yes..	No...	½ mile.....	Company and insurance company.
126	232	First aid to injured at plant.....	Yes..	No...	½ mile.....	First aid, company; at hospital, State.
127	267	Clerk gives immediate attention and when necessary calls doctor.	Yes..	No...	1 mile.....	Insurance company, 80 per cent; company, 20 per cent.
128	121	First aid rendered in laboratory.....	Yes..	No...	2 miles.....	Insurance company.
129	177	Call doctor.....	Yes..	No...	10 miles.....	Do.
130	170	Sent to hospital.....	Yes..	No...	½ mile.....	Company.
131	184	Antiseptic treatment and bandages.	Yes..	No...	1 mile.....	Patient, if charge is made.
132	126	Contributions of money, coal, etc., to meet necessities are made by superintendent.	[1] ...	[1] ...	[1]	[1].
133	37	None.....	No...	.....	.....	
134	425	[1].....	Yes..	No...	1 mile.....	Company.
135	101	Send for doctor.....	Yes..	No...	2 miles.....	Do.
136	77	Have cot and emergency kit.....	Yes..	No...	5 miles.....	Do.
137	613	Emergency hospital at works.....	Yes..	No...	1½ miles.....	Insurance company, first aid; company for subsequent treatment.
138	1,019	.....do.....	Yes..	No...	2 miles.....	Benefit association.
139	353	Telephone at once for physician.....	Yes..	No...	6 miles.....	Patient.
140	201	Have a first-aid outfit.....	Yes..	No...	.....do.....	Injured.
141	147	Appliances for first aid to injured are kept at mill office.	Yes..	No...	Few blocks..	Treatment free; company contributes annually to hospital.
142	67	Keep disinfectants, bandages, etc...	Yes..	No...	4 miles.....	By subscription.
143	62	Regularly appointed doctor called...	No...	.....	.....	First attention by casualty company.
144	98	First-aid remedies and appliances on hand.	Yes..	No...	2 miles.....	Insurance company; injured.
145	62	Regularly employed doctor always on hand.	No...	.....	.....	Company by regular assessments on employees.
146	146	Company surgeon 300 yards from furnace.	Yes..	No...	75 miles.....	Company by assessments on employees.
147	78	Physician employed by the company	Yes..	No...	7 miles.....	Do.
148	109	Company's physician called; nurse provided.	No...	.....	.....	Do.
149	131	Company physician and surgeon....	Yes..	No...	24 miles.....	Do.
150	.....	City ambulance with physician called.	Yes..	No...	1 mile.....	Depends on circumstances.
151	237	Sent to hospital.....	Yes..	No...	.....do.....	Company, order of underwriters.
152	241	Doctor called or injured is sent to doctor's office.	Yes..	No...	2 miles.....	Company.
153	128	Have mixtures for burns.....	No...	.....	.....	[1].
154	104	Doctor called.....	Yes..	No...	1 mile.....	Mill company or insurance company.
155	170	Have small emergency accident case at plant.	Yes..	No...	.....do.....	Company.

[1] Not reported.

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APPENDIX H.—PROVISIONS FOR IMMEDIATE CARE OF INJURED AND FOR HOSPITAL SERVICE IN 530 IRON AND STEEL ESTABLISHMENTS REPORTING—Continued.

Plant number.	Number of employees.	Provision for immediate aid.	Further treatment.			Who bears expense of treatment?
			Is hospital used?	If hospital is used.		
				Is it owned by company?	Distance from plant.	
156	19	Have had no accidents that caused the loss of a day from work.	No...	.....	.....	(1).
157	203	Have an emergency supply.....	Yes..	No...	2 miles.....	Insurance company.
158	362	First-aid supplies; salaried physician.	Yes..	No...	2 blocks.....	Insurance company and mill company.
159	189	Slightly injured taken to doctor; seriously injured taken to hospital.	Yes..	No...	3 blocks.....	(1).
160	350	First attention by physician.....	Yes..	No...	(1).....	(1).
161	134	Injured sent in vehicle to nearest physician, or if unable to go physician is summoned.	Yes..	No...	¼ mile.....	First treatment by indemnity company.
162	70	Looked after at their homes at company expense.	No...	.....	.....	Company.
163	95	First-aid appliances.....	Yes..	No...	3 blocks.....	First aid, insurance company; after treatment, company.
164	74	Doctor called at company expense..	No...	.....	.....	(1).
165	139	(1).....	(1)...	(1)...	(1).....	(1).
166	109	Regular company physician takes charge.	No...	.....	.....	Company.
167	99	First aid by local physician and surgeon.	No...	.....	.....	(1).
168	576	Sent to local hospital.....	Yes..	Yes..	¾ mile.....	Injured person.
169	51	Company physician is called.....	No...	.....	.....	Employees, by monthly fees.
170	175	None.....	No...	.....	.....	Do.
171	54	Company doctor.....	No...	.....	.....	Company.
172	481	Sent home or to hospital.....	Yes..	No...	2 miles.....	First aid, insurance company.
173	105	Call doctor, who can reach the plant in 15 minutes.	No...	.....	.....	Employees, by monthly fees.
174	45	None.....	No...	.....	.....	Company, if at fault; injured, if due to negligence.
175	766	Have an emergency room equipped with first-aid supplies.	Yes..	No...	3 miles.....	Company.
176	171	Have surgeon at the works and temporary hospital with fully equipped operating room.	Yes..	Yes..	1,000 feet....	Do.
177	97	Company physician.....	No...	.....	.....	Do.
178	154	Company physician, with office containing paraphernalia, at plant.	Yes..	No...	3 miles.....	Employees, by monthly fees.
179	.....	Company physician.....	Yes..	No...	3 miles.....	Do.
180	54	Taken home and physician called...	No...	.....	.....	Company, liability company, or injured person.
181	125	Call of surgeons.....	No...	.....	.....	(1).
182	165	Doctor called; injured sent home or to hospital.	Yes..	No...	17 miles.....	Company.
183	.....	None.....	No...	.....	.....	Employees.
184	141	Supplies for temporary relief carried in timekeeper's room.	Yes..	No...	2 miles.....	Company, 20 per cent; insurance company, 80 per cent.
185	71	Have company doctor.....	Yes..	No...	2 miles.....	Company.
186	122	Doctor employed by men through company to care for accidents and sickness.	Yes..	No...	4 miles.....	Do.
187	132	Doctor called.....	Yes..	No...	2 miles.....	Do.
188	356	Have first aid in charge of competent man; prompt attention of physician.	Yes..	No...	8 miles.....	First aid, company; all expense, sometimes company.
189	142	First medical aid only.....	No...	.....	.....	(1).
190	132	Doctor called.....	Yes..	No...	8 miles.....	Company.
191	173	First-aid man on premises during day.	Yes..	No...	2 miles.....	Do.
192	341	Company physician.....	No...	.....	.....	Do.
193	277	Medical aid provided.....	Yes..	No...	1½ miles.....	Do
194	475	First aid by company's surgeon.....	Yes..	No...	3 miles.....	Do.

(1) Not reported.

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APPENDIX H.—PROVISIONS FOR IMMEDIATE CARE OF INJURED AND FOR HOSPITAL SERVICE IN 530 IRON AND STEEL ESTABLISHMENTS REPORTING—Continued.

Plant number.	Number of employees.	Provision for immediate aid.	Further treatment.			Who bears expense of treatment?
			Is hospital used?	If hospital is used.		
				Is it owned by company?	Distance from plant.	
195	162	Medical attendance provided	Yes	No	1 mile	Company.
196	327	First-aid appliances on hand	Yes	No	½ mile	Liability company.
197	321	First aid rendered at works	Yes	No	1½ miles	Company.
198	384	Sent to doctor; doctor called; sent home or to hospital.	Yes	No	1 mile	Do.
199	1,025	Emergency room with supplies	Yes	No	½ mile	
200	.....	None	No	.....	.....	(1).
201	82	Immediate attention	No	.....	.....	(1).
202	94	Resident doctor called	No	.....	.....	Insurance company pays first-aid charges.
203	248	Taken to near-by hospital and doctor called.	Yes	No	½ mile	Company.
204	120	None, except to call a physician	Yes	No	1 mile	Do.
205	67	Few first-aid appliances in manager's office; doctor called.	No	.....	.....	Do.
206	69	Taken to hospital or home	Yes	No	(2)	Company, usually.
207	.....	do	Yes	No		
208	25	None	(1)	(1)	(1)	(1).
209	134	do	No	.....	.....	(1).
210	322	Arrangement to call one of three doctors to come to the plant.	Yes	No	½ mile	Company.
211	188	Ambulance and doctor called; injured taken to hospital.	Yes	No	½ mile	Do.
212	260	Taken to physician's office, home, or hospital.	Yes	No	2 blocks	Company, employee, or liability company.
213	98	Ambulance and physician called	No	.....	.....	Insurance company part.
214	22	Have a first-aid outfit	Yes	No	2 blocks	Company.
215	94	Telephone for city doctor	Yes	No	1 mile	None incurred so far.
216	445	Emergency hospital in plant	Yes	No	½ mile	Company.
217	55	Sent to company doctor	No	.....	.....	Company, first treatment.
218	292	Doctor called	Yes	No	1 mile	Insurance company.
219	225	Minor injuries cared for at factory; doctor called for more serious accidents.	Yes	No	¾ mile	Do.
220	347	Chemist gives first-aid treatment in laboratory.	Yes	No	1 mile	Company.
221	131	Keep on hand bandages and first aids.	Yes	No	17 miles	Do.
222	4	Physician near by attends injured	No	.....	.....	Do.
223	21	None	No	.....	.....	(1).
224	390	First-aid care covered by liability insurance.	Yes	No	(1)	Insurance company.
225	73	Physician called; injured taken home	Yes	No	½ mile	Company.
226	14	Doctor across street	Yes	No	1 mile	Do.
227	659	Telephone doctor; render first aid	Yes	No	1½ miles	Company, first treatment.
228	347	Bandages and other appliances for first aid.	Yes	No	2 miles	Company furnishes surgeon.
229	90	Call doctor and ambulance if necessary.	Yes	No	1½ miles	Insurance company.
230	333	Medical aid called; injured taken home if necessary.	No	.....	.....	Company, first treatment.
231	(1)	Quick communication with resident doctors.	No	.....	.....	Depends on nature of case.
232	292	Placed in hands of liability company's surgeon.	Yes	No	1½ miles	Liability company or injured.
233	149	First-aid outfit at plant	No	.....	.....	Insurance company.
234	656	Have the doctor come to plant immediately.	Yes	No	1 mile	Company.
235	24	Have on hand first-aid treatment	Yes	No	3 miles	Do.
236	457	Sent to doctor's office or hospital	Yes	No	¾ mile	Do.
237	456	Use first aid to injured and send for doctor.	Yes	No	2 miles	Do.
238	342	Have quick first-aid requisites; call company surgeon.	Yes	No	27 miles	Company and liability company.

[1] Not reported.

[2] Two blocks from one, ½ mile from other.

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APPENDIX H.—PROVISIONS FOR IMMEDIATE CARE OF INJURED AND FOR HOSPITAL SERVICE IN 530 IRON AND STEEL ESTABLISHMENTS REPORTING—Continued.

Plant number.	Number of employees.	Provision for immediate aid.	Further treatment.			Who bears expense of treatment?
			Is hospital used?	If hospital is used.		
				Is it owned by company?	Distance from plant.	
239	38	Sent to hospital	Yes	No	¼ mile	First aid, insurance company; other, injured.
240	121	Regular surgeon, to whom all cases are sent.	Yes	No	26 miles	Insurance company and steel tool company.
241	2,487	Sent to physician or to hospital	Yes	No	5 blocks	Insurance company.
242	38	Surgeon is called	Yes	No	½ mile	Do.
243	470	Sent to nearest physician or hospital.	Yes	No	(1)	Insurance company and company.
244	507	Call hospital ambulance	Yes	No	8 blocks	Do.
245	140	Surgical attention gratis by company surgeon.	Yes	No	1½ blocks	Company and patient.
246	387	Have first-aid dispensary and company surgeon.	No			Injured.
247	159	First-aid hospital at the plant	Yes	No	2 miles	$1 per year by employee provides treatment.
248	46	Bandages and medical supplies in office.	(1)	(1)	(1)	(1).
249	461	Near-by surgeon called	Yes	No	2½ miles	Liability company.
250	92	Cots, blankets, emergency medicine supplies, bandages, etc.	Yes	No	5 blocks	Company.
251	132	An emergency hospital is provided	Yes	No	½ mile	Depends on circumstances.
252	115	Injured sent to doctor's office or hospital or doctor called.	Yes	No	8 blocks	Company.
253	136	Doctor, employed by company's benevolent association, called.	Yes	No	2 blocks	Company's benevolent association.
254	99	Red Cross emergency cabinet	No			Company if culpable; insurance company otherwise.
255	231	First aid, local physicians	Yes	No	25 miles	Insurance company.
256	87	Taken to their homes and physician called.	No			Company.
257	1,244	Several emergency rooms with supplies.	Yes	No	3 blocks	
258	26	Call the doctor	(1)	(1)	(1)	Liability insurance company.
259	786	First-aid hospital at plant	Yes	No	½ mile	Insurance company.
260	37	Have first-aid medical box	Yes	No	(1)	Liability insurance company.
261	(1)	Doctor and hospital	Yes	No	(1)	Insurance company.
262	77	Send to doctor	No			Do.
263	133	Hospital room with emergency outfit	Yes	No	¼ mile	Company.
264	26	Have had no accidents; made no provision.	No			
265	247	Taken to nearest physician	Yes	No	800 feet	Insurance company, first aid.
266	121	First aid rendered by chemist; further assistance by surgeon located 6 blocks away.	Yes	No	5 miles	Do.
267	163	Simple remedies administered in laboratory by the company chemist.	Yes	No	2 miles	Company.
268	95	Company doctor	Yes	No	115 miles	Do.
269	267	Bandages and medicines for treatment; doctor within 3 blocks.	Yes	No	4 blocks	Do.
270	209	Injured taken to a physician	Yes	No	1 mile	Company, first aid; insurance company, further.
271	1,207	Operating room on premises; doctor within call.	No			Company.
272	(1)	Sent to company physician or he or any local physician is called.	Yes	Yes	½ mile	Hospital fund deducted from employees' pay.
273	176	Doctor	Yes	No	4 miles	Company.
274	118	Emergency kit for minor injuries; doctor for serious cases.	No			Company, first treatment; injured, further.
275	207	Emergency supplies kept on hand	Yes	No	14 blocks	Fund deducted from employees' pay.

[1] Not reported.

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APPENDIX H.—PROVISIONS FOR IMMEDIATE CARE OF INJURED AND FOR HOSPITAL SERVICE IN 530 IRON AND STEEL ESTABLISHMENTS REPORTING—Continued.

Plant number.	Number of employees.	Provision for immediate aid.	Further treatment.			Who bears expense of treatment?
			Is hospital used?	If hospital is used.		
				Is it owned by company?	Distance from plant.	
276	69	First aid given in mill	Yes	No	4 blocks	Insurance company.
277	117	First-aid remedies kept at works; send in ambulance to doctor's office or hospital.	Yes	No	1 mile	Do.
278	543	First-aid and other necessary medical and surgical supplies carried at plant.	Yes	Yes	2 blocks	Company, partly paid from monthly deductions from employees' pay.
279	90	Send injured to nearest doctor. (Never had a case more than hand hurt against casting grinder.)	[1]	[1]	[1]	[1].
280	887	First aid is rendered	Yes	No	2½ miles	Company.
281	331	First aid to injured, followed by call for doctor.	Yes	No	4 blocks	Casualty company.
282	66	Local physician called	Yes	No	½ mile	Depends upon who is in fault.
283	[1]	Treated temporarily at plant	Yes	No	¾ mile	Forge company and insurance company.
284	68	Notify hospital at once	Yes	No	10 minutes' drive.	Insurance company.
285	53	Physician summoned and his instructions followed.	[1]	[1]	[1]	[1].
286	227	Placed immediately under the doctor's care.	Yes	No	10 miles	Company.
287	429	Company has emergency hospital for first aid.	Yes	No	1 mile	Do.
288	[1]	First aid rendered at plant and doctor called	Yes	No	[1]	Company, first; insurance company, further.
289	[1]	Nearest doctor called	Yes	No	2 miles	Company pays doctor's first-aid charges and collects from accident insurance company.
290	139	Doctor called	Yes	No	1 mile	Company and insurance company.
291	[1]	Company has doctor	No			[1].
292	233	Medical attention	Yes	No	2,500 feet	Relief fund.
293	11	First aid to the injured	Yes	No	½ mile	Company.
294	52	[1]	[1]	[1]	[1]	[1].
295	21	First-aid attention	Yes	No	6 blocks	Company.
296	124	Have in store preparation for burns and bruises; severe cases sent to doctor, 1 mile away.	Yes	No	8 miles	Company and insurance company.
297	9	First-aid supplies on hand; foreman and men help until doctor arrives.	No			Company, if in fault. No accidents yet.
298	[1]	Maintain room for emergency treatment.	Yes	No	25 miles	Company.
299	44	First-aid materials kept in shop	Yes	No	1½ miles	Company or insurance company.
300	50	Free medical attention	Yes	No	Several miles	No fixed rule.
301	10	Kit of medical applications	No			Have had none.
302	28	Liability insurance company	No			Insurance company, first aid.
303	150	Minor injuries treated at shop; serious ones taken to hospital.	Yes	No	10 blocks	Company.
304	78	Have on hand a small medicine chest	Yes	No	½ mile	Hospital.
305	52	We pay their time while out of commission on account of accidents.	No			[1].
306	564	Temporary hospital in shop	Yes	No	2 miles	Insurance company.
307	17	Supply of ointments, disinfectants, and bandages kept on hand; employee's family physician called in serious cases.	No			Company.
308	256	First-aid supplies on hand; doctor's office within 100 yards of plant.	Yes	No	3½ miles	Do.
309	[1]	Local physician and aid	Yes	No	3 miles	As arranged; have had no serious accident.
310	32	Family doctor	No			Company.

[1] Not reported.

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APPENDIX H.—PROVISIONS FOR IMMEDIATE CARE OF INJURED AND FOR HOSPITAL SERVICE IN 530 IRON AND STEEL ESTABLISHMENTS REPORTING—Continued.

Plant number.	Number of employees.	Provision for immediate aid.	Further treatment.			Who bears expense of treatment?
			Is hospital used?	If hospital is used.		
				Is it owned by company?	Distance from plant.	
311	22	No accidents, hence no provision made.	No...	.....	.....	(1).
312	697	An employee attends slight injuries; a physician is employed by the year.	Yes..	No...	16 blocks....	Company, generally.
313	160	All general first-aid remedies on hand and local doctor called.	Yes..	No...	1 mile.....	No definite rule.
314	429	Company doctor and temporary hospital outfit at mills.	Yes..	No...	.....do.....	Company.
315	339	Material for bandages and sundries for use in accidents are kept on hand.	Yes..	No...	3 blocks.....	(1).
316	192	First-aid cabinet used by superintendent or assistant.	Yes..	No...	8 minutes...	Company.
317	249	Accident insurance company.....	No...	.....	.....	(1).
318	114	No special provision is made.....	Yes..	No...	¼ mile.....	Company, when necessary.
319	759	Emergency hospital; nurse in attendance; surgeon on call.	Yes..	No...	10 miles.....	Company.
320	153	Emergency room; surgeon on call...	.....	.....	.....	Do.
321	539	Emergency hospital; nurse constantly in attendance.	Yes..	No...	¼ mile.....	Do.
322	4,223	Emergency stations with central hospital; surgeons in constant attendance.	Yes..	No...	¾ mile.....	Do.
323	827	Emergency hospital; nurse in attendance; surgeon on duty during day.	Yes..	No...	1 mile.....	Do.
324	3,850	Emergency stations with central hospital; surgeons and nurses in constant attendance.	.....	.....	.....	Do.
325	1,536	Emergency hospital; nurse in attendance; surgeon on call.	Yes..	No...	3 miles.....	Do.
326	194	Emergency room; surgeon on call...	.....	.....	.....	Do.
327	(1)	Emergency hospital; nurse in attendance; surgeon on call.	Yes..	No...	1 mile.....	Do.
328	3,768	Emergency hospital; nurses in attendance constantly, surgeons during day.	Yes..	No...	6 miles.....	Do.
329	378	Emergency room; surgeon on call...	Yes..	No...	2 miles.....	Do.
330	288	.....do.....	Yes..	No...	1½ miles.....	Do.
331	1,827	.....do.....	Yes..	No...	2 miles.....	Do.
332	761	.....do.....	Yes..	No...	½ mile.....	Do.
333	4,112	Emergency hospital; nurse in constant attendance, surgeon much of the time.	Yes..	No...	7 miles.....	Do.
334	977	Emergency room at office; surgeon in attendance during day, on call at night.	Yes..	No...	2½ miles.....	Do.
335	(1)	Emergency room in plant; nurse in attendance.	Yes..	No...	2 miles.....	Do.
336	(1)	Detached emergency hospital; nurse in attendance; surgeon on call.	Yes..	No...	1½ miles.....	Do.
337	305	Detached emergency hospital in charge of skilled attendant; daily visits of surgeon.	Yes..	No...	2 miles.....	Do.
338	278	Emergency room; surgeon on call...	Yes..	No...	7 miles.....	Do.
339	284	Emergency supplies in office; surgeon on call.	Yes..	No...	6 miles.....	Do.
340	210	Emergency room; surgeon on call...	Yes..	No...	2 miles.....	Do.
341	(1)	Detached emergency hospital in charge of nurse; surgeon on call.	Yes..	No...	35 miles.....	Do.
342	1,564	Detached hospital; nurse in charge; surgeon on call.	Yes..	No...	.....do.....	Do.
343	866	Detached emergency hospital; attendant in charge; surgeon on call, makes daily visits.	Yes..	No...	1 mile.....	Do.
344	422	Detached emergency hospital; surgeon.	Yes..	No...	2 miles.....	Do.

(1) Not reported.

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APPENDIX H.—PROVISIONS FOR IMMEDIATE CARE OF INJURED AND FOR HOSPITAL SERVICE IN 530 IRON AND STEEL ESTABLISHMENTS REPORTING—Continued.

Plant number.	Number of employees.	Provision for immediate aid.	Further treatment.			Who bears expense of treatment?
			Is hospital used?	If hospital is used.		
				Is it owned by company?	Distance from plant.	
345	1,054	Detached emergency hospital; surgeon in constant attendance.	Yes..	No...	2 miles.....	Company.
346	703	Emergency room; surgeon on call...	Yes..	No...	½ mile.....	Do.
347	247	Emergency room in plant; constant attendant; surgeon under salary.	Yes..	No...	.....do.....	Do.
348	299	Emergency supplies in office; surgeon on call.	Yes..	No...	1½ miles.....	Do.
349	590	.....do.....	Yes..	No...	3 miles.....	Do.
350	225	Emergency supplies in office; daily visits of surgeon, constantly on call.	Yes..	No...	1 mile.....	Do.
351	191	Emergency room; attendant in charge; daily visits from surgeon who is constantly on call.	Yes..	No...	2 miles.....	Do.
352	(1)	Emergency room in plant; surgeon on call.	Yes..	No...	1½ miles.....	Do.
353	(1)	Emergency supplies in office; surgeon on call.	Yes..	No...	2 miles.....	Do.
354	(1)	Detached emergency hospital; surgeon on call.	Yes..	No...	½ mile.....	Do.
355	(1)	Emergency room; surgeon on call..	Yes..	No...	1 mile.....	Do.
356	(1)	Detached emergency hospital; daily visits of surgeon.	Yes..	No...	2½ miles.....	Do.
357	(1)	Detached emergency hospital; constant attendance of surgeon.	Yes..	No...	2 miles.....	Do.
358	(1)	Emergency room in plant; surgeon on call.	Yes..	No...	.....do.....	Do.
359	(1)	.....do.....	Yes..	No...	1 mile.....	Do.
360	(1)	.....do.....	Yes..	No...	1½ miles.....	Do.
361	969	Emergency room; surgeon on call...	Yes..	No...	3 miles.....	Do.
362	6,612	Emergency hospital; surgeon or nurse in constant attendance.	Yes..	No...	9 miles.....	Do.
363	626	Emergency rooms; surgeon on call..	Yes..	No...	1½ miles.....	Do.
364	1,141	.....do.....	Yes..	No...	½ mile.....	Do.
365	632	.....do.....	Yes..	No...	.....do.....	Do.
366	1,287	.....do.....	Yes..	No...	1 mile.....	Do.
367	893	.....do.....	Yes..	No...	1½ miles.....	Do.
368	376	.....do.....	Yes..	No...	2 miles.....	Do.
369	716	.....do.....	Yes..	No...	.....do.....	Do.
370	736	.....do.....	Yes..	No...	.....do.....	Do.
371	(1)	.....do.....	Yes..	No...	1 mile.....	Do.
372	211	.....do.....	Yes..	No...	15 miles.....	Do.
373	567	.....do.....	Yes..	No...	3 miles.....	Do.
374	2,953	Emergency hospital; surgeon in constant attendance.	Yes..	No...	1½ miles.....	Do.
375	1,394	Emergency room; surgeon on call...	Yes..	No...	3 miles.....	Do.
376	(1)	.....do.....	Yes..	No...	1 mile.....	Do.
377	261	Separate emergency hospital; nurse in attendance; surgeons on call.	Yes..	No...	.....	
378	287	Detached emergency hospital; trained nurse in constant attendance; surgeon at call.	Yes..	No...	.....	Do.
379	1,442	Detached emergency hospital recently completed; nurse in attendance.	Yes..	No...	½ mile.....	Do.
380	1,376	Emergency hospital; surgeon on call.	Yes..	No...	1 mile.....	Do.
381	450	No supplies at works; surgeon's office 3 blocks from plant.	Yes..	No...	4½ miles.....	Do.
382	152	Emergency room; surgeon on call...	Yes..	Yes..	1½ miles.....	Do.
383	2,060	Hospital 6 blocks from works; emergency hospital nearly completed.	Yes..	No...	6 blocks.....	Do.
384	160	Emergency room at plant; local surgeon called.	Yes..	No...	2 miles.....	Do.
385	(1)	.....do.....	Yes..	No...	5 miles.....	Do.
386	.....	.....do.....	Yes..	No...	5½ miles.....	Do.
387	2,637	Emergency hospital at works; surgeon in attendance.	Yes..	No...	1 mile.....	
388	1,181	Emergency hospital at works; surgeon on call.	Yes..	No...	.....do.....	Do.

[1] Not reported.

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APPENDIX H.—PROVISIONS FOR IMMEDIATE CARE OF INJURED AND FOR HOSPITAL SERVICE IN 530 IRON AND STEEL ESTABLISHMENTS REPORTING—Continued.

Plant number.	Number of employees.	Provision for immediate aid.	Further treatment.			Who bears expense of treatment?
			Is hospital used?	If hospital is used.		
				Is it owned by company?	Distance from plant.	
389	7,072	Hospital at works; surgeons in constant attendance.	Yes..	Yes..	At works....	Company.
390	5,671	.....do.....	Yes..	Yes..	.....do.....	Do.
391	1,005	Emergency room; surgeon on call...	Yes..	No...	4 miles.....	Do.
392	1,707	Emergency hospital; nurse in attendance; surgeon on call.	Yes..	No...	15 miles.....	Do.
393	(1)	Emergency hospital at works.....	Yes..	No...	2 miles.....	Do.
394	(1)	.....do.....	Yes..	No...	.....do.....	Do.
395	966	Emergency hospital near plant.....	Yes..	No...	1½ miles.....	Do.
396	1,136	.....do.....	Yes..	No...	½ mile.....	Do.
397	108	.....do.....	Yes..	No...	1½ miles.....	Do.
398	663	.....do.....	Yes..	No...	2 miles.....	Do.
399	1,112	.....do.....	Yes..	No...	½ mile.....	Do.
400	133	First-aid appliances at plant.....	Yes..	No...	1½ miles.....	Do.
401	94	.....do.....	Yes..	No...	3 miles.....	Do.
402	583	First-aid supplies at plant.....	Yes..	No...	(1).....	Company has contract with physician.
403	376	First-aid supplies at plant; doctor called.	Yes..	No....	1 mile.....	Company.
404	638	First-aid supplies at plant.....	Yes..	No...	4 miles.....	Do.
405	5,382	Emergency hospital at works.....	Yes..	No...	6 miles.....	Employees, by monthly fees.
406	.....	Emergency hospital; surgeon in constant attendance.	Yes..	No...	½ mile.....	Hospital to which company contributes.
407	570	First-aid appliances; physician called	Yes..	No...	1½ miles.....	Company.
408	1,318	.....do.....	Yes..	No...	1 mile.....	Do.
409	403	Immediate care at company's expense.	Yes..	No...	.....do.....	Insurance company.
410	64	No special arrangements.....	No..	.....	.....	(1).
411	296	Maintain an emergency equipment and have a room where accidents are treated by competent attendant; company physician called for serious cases.	Yes..	No...	1¼ miles.....	Employees' benevolent association.
412	357	Have physician employed by the year.	Yes..	No...	1 mile.....	Company.
413	131	A physician is called.....	Yes..	No...	2 miles.....	Subscriptions among employees; company contributes to hospital.
414	227	Local physician.....	Yes..	No...	12 miles.....	Company.
415	925	First-aid outfit with experienced attendant.	Yes..	No...	Under 1 mile.	Do.
416	1,134	.....do.....	Yes..	Yes..	600 feet.....	Do.
417	195	Room reserved in office for injury cases.	Yes..	No...	½ mile.....	Company; sometimes insurance company.
418	543	Emergency outfits and physician's advice within few minutes.	Yes..	No...	3 miles.....	Company.
419	721	The services of a surgeon.....	Yes..	No...	½ mile.....	Do.
420	2,407	Dispensary on the plant, with surgeon in attendance day and night.	Yes..	No...	.....do.....	Do.
421	229	Services of a surgeon.....	Yes..	No...	.....do.....	Do.
422	617	.....do.....	Yes..	No...	.....do.....	Do.
423	650	.....do.....	Yes..	No...	.....do.....	Do.
424	218	.....do.....	Yes..	No...	.....do.....	Do.
425	1,130	Dispensary on the plant, with surgeon in attendance day and night.	Yes..	No...	.....do.....	Do.
426	1,066	.....do.....	Yes..	No...	.....do.....	Do.
427	288	Immediate care furnished at expense of company.	Yes..	No...	(2).....	Company contributes to hospital; employees contribute once a year to hospital.
428	104	Immediate care at expense of company.	Yes..	No...	18 miles.....	Hospital, to which company contributes.
429	172	.....do.....	Yes..	No...	14 miles.....	Do.
430	63	An emergency accident cabinet.....	Yes..	No...	4 miles.....	Company, by special and annual contributions to hospital.
431	121	Local doctor.....	Yes..	No...	.....do.....	Do.

[1] Not reported. [2] Two hospitals, one 3 and the other 6 miles distant.

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APPENDIX H.—PROVISIONS FOR IMMEDIATE CARE OF INJURED AND FOR HOSPITAL SERVICE IN 530 IRON AND STEEL ESTABLISHMENTS REPORTING—Continued.

Plant number.	Number of employees.	Provision for immediate aid.	Further treatment.			Who bears expense of treatment?
			Is hospital used?	If hospital is used.		
				Is it owned by company?	Distance from plant.	
432	48	None	No			(1).
433	111	Local doctor	Yes	No	9 miles	Hospital, which is reimbursed by annual and special contributions by the company.
434	452	Room is provided where injured are taken and a doctor is called at once.	Yes	No	4 miles	Indemnity company as paid agents of works.
435	700	Slight injuries taken to a doctor; serious ones to a hospital.	Yes	No	3 miles	Company.
436	332	Keep a small chest of first-aid requisites.	Yes	No	1½ miles	Hospital, to which company subscribes.
437	333	do	Yes	No	do	Do.
438	89	Red Cross medicine box, first aid to injured.	Yes	No	6 miles	(1).
439	309	do	Yes	No	½ mile	Hospital, to which company and men contribute.
440	177	do	Yes	No	do	Do.
441	440	do	Yes	No	1½ miles	Do.
442	99	do	Yes	No	½ mile	Do.
443	103	do	Yes	No	1½ miles	Do.
444	1,906	do	Yes	No	1 mile	Do.
445	272	do	Yes	No	do	Do.
446	940	do	Yes	No	10 miles	Hospital.
447	389	do	Yes	No	do	Do.
448	1,272	Temporary hospital; company physician.	Yes	No	½ mile	First treatment, company; further, beneficial society.
449	5,117	Emergency office with trained nurse in works and own ambulance.	Yes	No	2½ miles	Company.
450	528	Emergency chest in each department, equipped with first aid to injured.	Yes	No	¼ mile	Do.
451	1,225	Each mill is equipped with first-aid remedies.	Yes	No	½ mile	Company, usually reimbursed for first aid by insurance company.
452	10,163	First aid appliances at various points in mills.	Yes	Yes	1½ miles	Benefit association.
453		do	Yes	Yes	1 mile	Do.
454		do	Yes	Yes	2 miles	Do.
455	399	(1)	(1)	(1)	(1)	(1).
456	441	Bandaged at works and driven to hospital.	Yes	No	¼ mile	Company.
457	1,974	Have room fitted up for use as mill hospital, containing supplies and remedies.	Yes	No	1 mile	Do.
458	649	Hospital at works cares for minor injuries.	Yes	No	½ mile	Do.
459	682	Have arrangements with local physician to answer all calls at once.	Yes	No	1 mile	Injured, or in specific cases, company.
460	573	First aid at works	Yes	No	(1)	Company.
461	770	Hospital room	Yes	No	1½ miles	Do.
462	335	Emergency hospital at plant	Yes	No	2 miles	Do.
463	170	First aid; medical box in office; physician called.	Yes	No	3 miles	Do.
464	2,425	Have company doctor and temporary hospital at the works.	Yes	No	1 mile	Do.
465	970	First aid department in mill; neighborhood physician.	Yes	No	¾ mile	Do.
466	485	Company physician called at once	Yes	No	4 miles	Do.
467	(1)	do	Yes	No	do	First aid, insurance company; balance, iron company.
468	167	Company doctor with first-aid remedies kept in office.	No			(1).
469	74	First aid to injured; hospital room with 2 beds, stretchers, etc., at works; several physicians accessible.	Yes	No	3 miles	Mutual aid association of the company.

[1] Not reported.

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APPENDIX H.—PROVISIONS FOR IMMEDIATE CARE OF INJURED AND FOR HOSPITAL SERVICE IN 530 IRON AND STEEL ESTABLISHMENTS REPORTING—Continued.

Plant number.	Number of employees.	Provision for immediate aid.	Further treatment.			Who bears expense of treatment?
			Is hospital used?	If hospital is used.		
				Is it owned by company?	Distance from plant.	
470	283	Emergency hospital	Yes	No	3 miles	Company.
471	424	First-aid outfit at works	Yes	No	Under 1 mile	Do.
472	214	First aid at works; doctor if necessary.	Yes	No	5 miles	Do.
473	191	do	Yes	No	20 miles	Insurance company.
474	1,238	Taken to laboratory equipped for first aid.	Yes	No	1 mile	Company.
475	380	Taken to storeroom equipped for first aid.	Yes	No	4 miles	Do.
476	102	Emergency hospital at works with equipment and attendants.	Yes	No	do	Do.
477	4,208	do	Yes	No	do	Do.
478	152	Arrangement with near-by doctor to give first aid.	Yes	No	4 blocks	Company, first aid; insurance company, balance.
479	39	do	Yes	No	½ mile	Do.
480	239	do	Yes	No	do	Do.
481	97	do	Yes	No	do	Do.
482	105	do	Yes	No	do	Do.
483	293	Electric welding department: Arrangement with near-by doctor to give first aid.	Yes	No	do	Do.
484	(1)	Schmidt plant: Arrangement with near-by doctor to give first aid.	Yes	No	do	Do.
485	62	Arrangement with near-by doctor to give first aid.	Yes	No	do	Do.
486	2,693	Physician called	Yes	No	do	Company.
487	194	do	Yes	No	do	Do.
488	510	Hospital at plant; company doctor	Yes	No	(2)	Do.
489	327	Call doctor from town	Yes	No	3 miles	Do.
490	606	Prompt surgical aid is rendered; the necessary supplies are kept constantly on hand.	Yes	No	1½ miles	Do.
491	466	Taken to company laboratory for first aid.	Yes	No	3 miles	Insurance company.
492	889	Company temporary hospital at works; doctor in attendance day and night.	Yes	No	1½ miles	Employees' monthly collection.
493	159	Company physician attends them until recovery.	Yes	No	14 miles	Company.
494	101	To be cared for by accident company.	No			Insurance company.
495	293	None; physician within quick response.	No			Company.
496	242	Emergency case and room for treatment.	Yes	No	1 mile	Employees, by medical fee.
497	280	do	Yes	No	2 miles	Do.
498	1,468	Emergency hospital on ground; graduate doctor in attendance.	Yes	No	8 miles	Company.
499	292	Small room with cot in office	Yes	No	(1)	Insurance company.
500	82	Have on hand medical supplies and experienced attention.	No			(1).
501	954	First aid at place provided; doctor called.	Yes	No	3 miles	Company.
502	1,396	First-aid room on plant; doctor on duty during day; within close call at night.	Yes	No	1 mile	Do.
503	174	Injured are sent to company doctor	Yes	No	do	Do.
504	164	Have company physician; bandages and first relief in readiness in all departments.	Yes	No	½ mile	Do.
505	146	Company physician is employed; first relief in readiness in all departments.	No			(1).
506	341	First aid administered in laboratory in plant.	Yes	No	3 blocks	Insurance company.
507	530	Company doctor	Yes	No	2 miles	City hospital.
508	623	do	Yes	No	2½ miles	Company.
509	124	do	Yes	No	1½ miles	Do.
510	1,021	do	Yes	No	½ mile	Do.

[1] Not reported. [2] Two hospitals used; one 15 and the other 25 miles distant.

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APPENDIX H.—PROVISIONS FOR IMMEDIATE CARE OF INJURED AND FOR HOSPITAL SERVICE IN 530 IRON AND STEEL ESTABLISHMENTS REPORTING—Concluded.

Plant number.	Number of employees.	Provision for immediate aid.	Further treatment.			Who bears expense of treatment?
			Is hospital used?	If hospital is used.		
				Is it owned by company?	Distance from plant.	
511	236	Company doctor	Yes	No	2½ miles	Company.
512	39	do	Yes	No	4 miles	Do.
513	1,093	do	Yes	No	do	Do.
514	(1)	do	Yes	No	4½ miles	Do.
515	(1)	do	Yes	No	4 miles	Do.
516	(1)	do	Yes	No	1 mile	Do.
517	(1)	do	Yes	No	do	Do.
518	(1)	do	Yes	No	4 miles	Do.
519	293	do	Yes	No	2 miles	City hospital.
520	(1)	do	Yes	No	do	Do.
521	106	do	Yes	No	do	Company.
522	(1)	do	Yes	No	10 blocks	Do.
523	(1)	do	Yes	No	1½ miles	County hospital.
524	50	Injured are sent to hospital	No			Insurance company, first treatment.
525	135	No regular system	No			Each case treated on its merits.
526	57	None, other than call doctor	Yes	No	1½ miles	Company.
527	46	None	No			(1).
528	51	Usually sent to hospital	Yes	No	12 miles	Company or insurance company.
529	3,816	Detached emergency hospital; surgeons in constant attendance.	Yes	Yes	¾ mile	Company and employees by fees.
530	7,000	Emergency boxes in works	Yes	No	do	Company.

[1] Not reported.

APPENDIX I.—BENEFIT ASSOCIATION CONSTITUTION.

OBJECT.

The object of this association is to accumulate a fund for the benefit of its members, and those dependent upon them, in case of sickness, accident, or death, and in consideration of the obligations assumed by ——— Company, as specified in Article XIV of this constitution, entitled, "Agreement and guaranty," the release of ——— Company of and from all liability for damages resulting from accidents to members.

ARTICLE I.—DEPARTMENT COMMITTEES.

SECTION 1. Each department of ——— Company shall have a committee, consisting of 1 member of the association employed in it, and 1 additional member for each 100 members of the association, or fractional part thereof, employed in such department.

SEC. 2. The committee shall be chosen in each department by members of the association belonging to that department, and each department committee shall choose its own chairman and secretary.

ARTICLE II.—GENERAL COMMITTEE.

SECTION 1. The members of the department committees shall constitute a general committee, which shall choose its own chairman and secretary, and shall also elect annually 5 members of the association to act in conjunction with 4 members appointed by the general manager of the ——— Company as a board of directors.

SEC. 2. Subject to the approval of the board of directors, the general committee shall appoint relief committees, committees on membership, and such other committees as may be needed.

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ARTICLE III.—BOARD OF DIRECTORS.

SECTION 1. The board of directors shall elect a president, vice president, and secretary of the association, and such other officers as may be necessary.

ARTICLE IV.—MEMBERS.

SECTION 1. No person shall be admitted to membership in the association who is not an employee of the ——— Company, * * *.

SEC. 2. Members shall be classed with respect to dues and benefits as (1) general, (2) restricted or qualified, and (3) special.

SEC. 3. Persons ceasing to be employed as aforesaid shall cease to be members, and shall have no other rights, except as to benefits accrued and previously awarded to them by the board of directors, unless their membership shall be continued by a vote of the board of directors; upon being again employed, persons who have ceased to be members by reason of nonemployment as aforesaid, and whose membership has not been continued, may apply for and be reinstated without making an original application for membership.

SEC. 4. Applicants for membership shall become members upon the approval of the secretary of the association, who is ex officio chairman of the committee on membership, and after signing an agreement to be subject to the constitution, by-laws, and all the rules and regulations of the association.

SEC. 5. Members may be expelled, by vote of the board of directors, for any fraudulent representations or pretense in their application for membership or for relief.

ARTICLE V.—BENEFITS.

SECTION 1. All sickness and accident weekly benefits shall be subject to the approval of the board of directors, and all benefits for loss of fingers, foot, limb, blinding, or death shall be voted by the board of directors, and its decision shall be final in all cases, and no suit or action at law or in equity shall ever be maintained by any member, or his legal representative, for any benefits refused by the board of directors.

ARTICLE VI.—GENERAL CLASS.

SECTION 1. The general class shall be divided into two divisions as follows: Division 1—Members not over 45 years of age, who shall pay monthly dues of 90 cents (plus 10 cents as per Article VIII). Division 2—Members above the age of 45 years, and under the age of 55 years, who shall pay monthly dues of $1.15 (plus 10 cents as per Article VIII).

SEC. 2. Members of the general class shall be alike entitled to the following benefits: Five dollars per week for disability resulting from accident or sickness; $100 burial fee in case of death resulting from disease or from accident otherwise than as hereinafter provided for; $500 in case of the loss by actual separation at or above the wrist or ankle of a hand or foot by accident while at work, or in going to or returning from the same; $1,000 for fracture of spine by accident while at work, or in going to or returning from the same, where such fracture results in the irrecoverable loss of all use of legs; $250 for loss of all fingers by accident while at work (thumb remaining), amputation at or above knuckles, metacarpo-phalangical articulation; $250 for loss of thumb and first three fingers by accident while at work (little finger remaining), amputation at or above knuckles, metacarpo-phalangical articulation; $200 for loss of first three fingers by accident while at work (thumb and little finger remaining), amputation at or above knuckles, metacarpo-phalangical articulation; $100 for loss of thumb by accident while at work (four fingers remaining), amputation at middle of carpal bone, or above; $200 for loss of foot through instep by an accident while at work; $200 in case of the irrecoverable loss of the entire sight of an eye by accident while at work; $1,000 in case of total blindness resulting from accident while at work, or in case of death caused by accident while at work, or in going to or returning from the same: *Provided*, That such benefits shall not be cumulative, but the greater benefit shall cover the less, and if a lesser benefit shall have been paid, it shall be deducted from any greater benefit accruing to the same person from the same injury: *And provided further*, That such death or loss of a member or members shall occur within four months from the time the injury is received: *And provided further*, That no claim shall be allowed for loss of life or limb, or any other injury occasioned by the injured party being upon the tracks of any railroad, except at public or necessary and usual crossing of the same.

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ARTICLE VII.—RESTRICTED CLASS.

SECTION 1. The restricted or qualified class shall include employees who are above the age of 55 years and employees irrespective of age who, by reason of defective physical condition or other cause, are unable to pass such medical examination as may be required by the board of directors, and members of this class shall pay monthly dues of 50 cents, and shall be entitled to $5 per week for disability resulting from accident while at work or in going to or returning from work; $50 burial fee in case of death resulting from disease or from accident otherwise than as hereinafter provided for; $250 in case of the loss by actual separation at or above the wrist or ankle of a hand or foot by accident while at work, or in going to or returning from the same; $500 for fracture of spine by accident while at work or in going to or returning from the same, where such fracture results in the irrecoverable loss of all use of legs; $125 for loss of all fingers by accident while at work (thumb remaining), amputation at or above the knuckles, metacarpo-phalangical articulation; $125 for loss of thumb and first three fingers by accident while at work (little finger remaining), amputation at or above knuckles, metacarpo-phalangical articulation; $100 for loss of first three fingers by accident while at work (thumb and little finger remaining), amputation at or above knuckles, metacarpo-phalangical articulation; $50 for loss of thumb by accident while at work (four fingers remaining), amputation at middle of carpal bone, or above; $100 for loss of foot through instep by an accident while at work; $100 in case of the irrecoverable loss of the entire sight of an eye by accident while at work; $500 in case of total blindness resulting from accident while at work, or in case of death caused by accident while at work, or in going to or returning from the same: *Provided*, That such benefits shall not be cumulative, but the greater benefit shall cover the less, and if a lesser benefit shall have been paid, it shall be deducted from any greater benefit accruing to the same person from the same injury: *And provided further*, That such death or loss of a member or members shall occur within four months from the time the injury is received: *And provided further*, That no claim shall be allowed for loss of life or limb, or any other injury occasioned by the injured party being upon the tracks of any railroad, except at public or necessary and usual crossing of the same.

ARTICLE VIII.—PERMANENT DISABILITY AND SERVICE PENSION.

SECTION 1. All members of the association shall pay additional monthly dues of 10 cents, and the additional dues so paid shall constitute and provide a special fund for payment of an annuity to each member of the association who may be permanently disabled, as provided in the following section, and said fund shall be used for no other purpose.

SEC. 2. Any member of the association who shall be permanently disabled by accident while at work or in going to or returning from the same, shall be entitled to an annuity of $240 per year during the remaining term of his natural life, payable from said fund in monthly installments of $20.

The term "permanent disability" as used in this article shall be construed as disability preventing such member from thereafter performing any kind of work or from following any employment whatsoever.

All annuities for permanent disability shall be subject to the approval and award of the board of directors, who may revoke the same for just cause at any time.

Each member to whom an annuity shall be awarded under the provisions of this article, shall at least once in each year, or oftener if required by the board, furnish the secretary with proof of his continued existence, continued disability, and place of residence.

SEC. 3. Any member of the association in good standing, having reached the age of 70 years and upward, who shall have been in the service and employment of ——— Company * * * for a substantially continuous period of 30 years, and who shall, in the judgment of the board of directors, be unable to perform further work or service by reason of infirmity, shall be entitled to an annuity of $240 per year during the remaining term of his natural life, payable from said fund in monthly installments of $20.

SEC. 4. If at any time the said "permanent disability" fund is insufficient to pay in full all annuities awarded and charged against it, payment on account of such annuities shall be made pro rata.

ARTICLE IX.—SPECIAL CLASS.

SECTION 1. Members under the age of 45 years entering the first division of the above general class, or belonging thereto, and passing a physical examination satisfactory

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to the board, may elect to pay 25 cents monthly, in addition to the dues payable in the division to which they belong, and, subject to the foregoing provisions, they shall be entitled to an increase of $300 to the funeral expenses, or burial fee, or death benefit, payable in the class to which they belong, as hereinbefore set forth, which dues shall be designated as special dues, and which benefits shall be designated as special benefits.

SEC. 2. The board of directors may, by resolution, suspend the special dues and special benefits provided for in section 1 of this article whenever in their judgment the interests of the association require such action.

ARTICLE X.—PAYMENT OF DUES.

SECTION 1. All monthly dues shall be payable on pay day in each month, and a failure to make payment of dues for one month shall forfeit the right to benefits, and the membership of the person so failing shall be suspended until he shall bring his case before the board of directors, who may reinstate him or end his membership by refusing to do so.

SEC. 2. New members shall pay an initial fee of $2, and upon compliance with the provisions of section 4, Article IV, shall become beneficial.

ARTICLE XI.—PAYMENT OF BENEFITS.

SECTION 1. Weekly sick benefits shall not begin until after one week's sickness, and shall date from the beginning of the second week, and shall be paid for by weeks or fractional parts thereof; and weekly accident benefits shall begin from the date of the accident: *Provided*, That no benefits shall be paid for first week on account of any accident or injury which does not produce a visible or external mark: *Provided, however*, That the directors have discretionary power to pay benefits for first week when sufficient proof is presented that the applicant is entirely disabled from work by reason of sprain or other injury leaving no external mark. Weekly benefits shall not be payable for a period of more than 17 weeks for any one sickness or injury: *Provided*, That the directors may in their discretion award weekly benefits for a further period not exceeding 10 weeks in cases where the facts in their judgment justify such additional benefits in furtherance of the objects of the association. No member shall be entitled to weekly benefits in more than one class or section.

SEC. 2. No sick benefits will be paid until the secretary or treasurer receives a certificate signed by an examining physician appointed or approved by the board of directors. A member shall be entitled to receive weekly benefits only for the time, as aforesaid, during which he is totally incapable of following his usual or other occupation.

SEC. 3. Members may designate on their application the person to whom their burial fees and accident death benefits shall be paid, and in the absence of such designation they will be paid to the husband, or widow, or children, or parents, or parent of the deceased, in order of preference aforesaid, and to no other relative, without any liability to creditors, upon such proof as the constitution, by-laws, and board of directors may require: *Provided*, That no designation heretofore or hereafter made shall deprive the legal husband, or widow, or children, or parents of the deceased of their respective right to claim and receive the accidental death benefit awarded in the order of preference aforesaid: *And provided further*, That in cases where no one appears to take charge of the interment of a deceased member, the secretary of the association may make arrangements for the suitable interment of such deceased member, and the board of directors may authorize the payment of necessary funeral expenses (not to exceed the sum of $100) out of the benefits or burial fees awarded on account of such member, directly to the person or persons having proper claims in connection with such funeral, and the amount thus paid shall be deducted from the total benefits awarded in such case.

ARTICLE XII.—HOSPITAL.

SECTION 1. The board of directors is authorized to take charge of, organize, and maintain the hospital * * * upon such terms and conditions and under such rules and regulations as may be agreed to by the board of directors and ——— Company.

SEC. 2. Members of this association shall have the right of admission in said hospital, in accordance with its rules, and shall have preference over persons who are not members.

SEC. 3. The weekly benefits of members admitted to the hospital who have no families dependent upon them for support, shall, during such times as they are inmates, be transferred and paid over to the fund for the maintenance of the hospital, and no other or further charges shall be made against members on account of hospital treatment received.

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SEC. 4. Nonmembers who may be admitted to the hospital shall be charged such hospital fees as may be fixed by the rules for government of the hospital.

ARTICLE XIII.—DISABILITY.

SECTION 1. No member shall be entitled to any benefits for disability or death occasioned by accident or injury received or chronic disease contracted before he became a member, or caused by intoxication or the violation of any law, or by willful or gross negligence on his part; and the accident which shall entitle any member to benefits shall be such as he is exposed to in his employment, or in going to or returning from the same.

SEC. 2. No burial fee shall be paid in case the death has been caused by intoxication or any act of the decedent in violation of law: *Provided, however*, That the directors may, in their discretion, award not exceeding $100 for funeral expenses where claims for accidental death benefits have been rejected and where the facts, in their opinion, justify such voluntary and discretionary payment.

ARTICLE XIV.—AGREEMENT AND GUARANTY.

SECTION 1. This association is based upon an agreement of ——— Company to act as treasurer of the association and to supply office room and clerical services without cost to the association; also to give an annual gratuity to the treasury, equal to $1 for each member of the association entitled to benefits during the whole year; also to guarantee the payment of all benefits to the members of the association by an advance or loan to the association from time to time of such sum or sums as may be needed, which shall be repaid from surplus income of the association from time to time, as it may be able so to do; in consideration of which every applicant for membership shall execute a release to the company employing him, herein named, of all action for damages resulting from accidents to him while he is a member of this association.

SEC. 2. The ——— Company may cancel its agreement and end the same by giving six months' previous notice to the chairman of the association of its intentions so to do, at the expiration of which notice said agreement shall be at an end, and the association shall be dissolved.

SEC. 3. Upon the dissolution of the association, the ——— Company shall have the right to appropriate the surplus money in the treasury, if any there shall be, to the use of the ——— Library Association, or to any hospital for workingmen of the company then in existence.

ARTICLE XV.—BY-LAWS.

SECTION 1. The by-laws of the association shall prescribe the time and manner of holding elections, the duties of officers, the meetings of the directors and committees, and such other matters as are not provided for herein. They shall be adopted by the board of directors.

ARTICLE XVI.—AMENDMENTS.

SECTION 1. The constitution may be amended by a vote of the general committee, at a meeting called for the purpose, after such amendment has been agreed to by the board of directors and by the ——— Company.

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